NPS 68-85-001

NAVAL POSTGRADUATE SCHOOL

Monterey, California

HYDROGRAPHIC DATA FROM THE OPTOMA PROGRAM
OPTOMA4, LEGS I AND II
26 MARCH - 10 APRIL, 1983

by

Michele M. Rienecker
Paul A. Wittmann
Edward A. Kelley
Marie C. Colton
Christopher N.K. Mooers

January 1985

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Prepared for:
of Naval Research
mental Sciences Directorate (Code 420)
on, VA 22217

NAVAL POSTGRADUATE SCHOOL

Monterey, California 93943

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This report is for the research project "Ocean Prediction Through Observations, Modeling and Analysis" sponsored by the Physical Oceanography Program of the Office of Naval Research under Program Element 61153N.

This report was Prepared by:

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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: NPS68-85-001
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:

4. TITLE *(and Subtitle)*: HYDROGRAPHIC DATA FROM THE OPTOMA PROGRAM OPTOMA4, LEGS I AND II, 26 MARCH - 10 APRIL, 1983

5. TYPE OF REPORT & PERIOD COVERED: Report for October 1982 to January 1985

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): Michele M. Rienecker, Paul A. Wittmann, Edward A. Kelley, Marie C. Colton, Christopher N.K. Mooers

8. CONTRACT OR GRANT NUMBER(s):

9. PERFORMING ORGANIZATION NAME AND ADDRESS: Naval Postgraduate School, Monterey, CA 93943

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 61153N, N0001484WR24051

11. CONTROLLING OFFICE NAME AND ADDRESS: Office of Naval Research (Code 420), Arlington, VA 22217

12. REPORT DATE: January 1985

13. NUMBER OF PAGES: 69

14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*:

15. SECURITY CLASS. *(of this report)*: UNCLASSIFIED

15a. DECLASSIFICATION DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT *(of this Report)*: Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*:

18. SUPPLEMENTARY NOTES:

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*:
California Current Systems
Physical oceanography
Dynamic oceanography

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*:

The cruise OPTOMA4 was undertaken in March and April, 1983 to sample two subdomains of the California Current System. This report presents the hydrographic data, acquired by XBT and CTD casts, from the cruise.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-LF-014-6601

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

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26 March - 10 April, 1983

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Michele M. Rienecker
Paul A. Wittmann
Edward A. Kelley
Marie C. Colton
Christopher N. K. Mooers

Chief Scientists: J. A. Smith and C. N. K. Mooers

The **OPTOMA** Program is a joint program of

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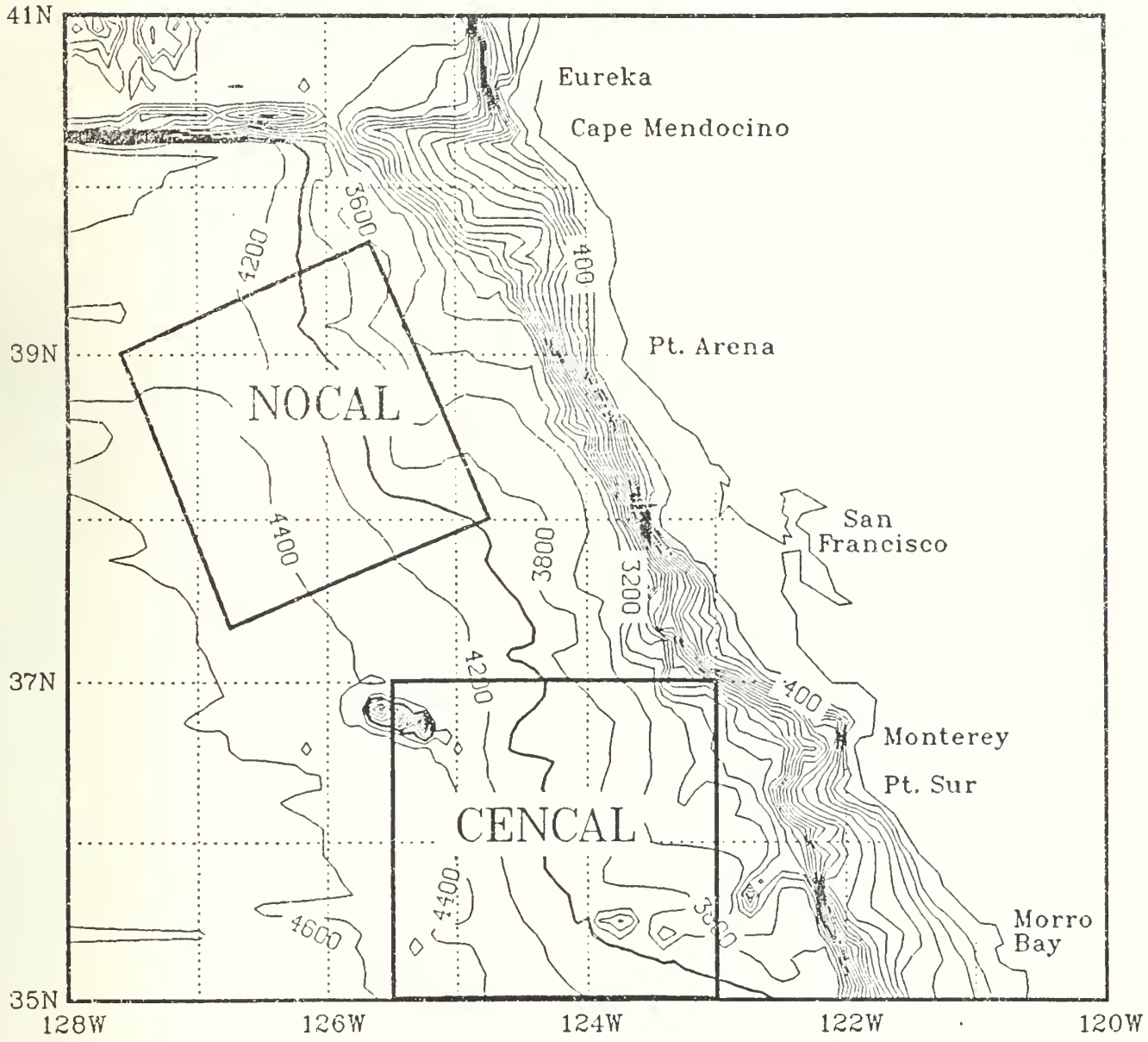

Figure 1: The NOCAL and CENCAL subdomains of the OPTOMA Program. Isobaths are shown in meters.

INTRODUCTION

The OPTOMA (Ocean Prediction Through Observations, Modeling and Analysis) Program, a joint NPS/Harvard program sponsored by ONR, seeks to understand the mesoscale (fronts, eddies, and jets) variability and dynamics of the California Current System and to determine the scientific limits to practical mesoscale ocean forecasting. To help carry out the aims of this project, a series of cruises has been planned in two subdomains, NOCAL and CENCAL, shown in Figure 1.

The cruise OPTOMA4 was undertaken, in the R/V ACANIA, for two weeks in March and April, 1983 and covered parts of the NOCAL and CENCAL domains, each roughly 200 km square centered 150 km off the California coast from Pt. Arena and Pt. Sur, respectively.

Hydrographic data were acquired during two legs: Leg I was carried out during the period 26 March to 1 April and sampled an area 160 km cross-shore by 170 km alongshore with additional transects to and from the NOCAL domain as shown in Figure 2. The transect extremes are identified by letter to aid in the cross-referencing of data presented in subsequent figures. Leg II was carried out during the period 5 to 10 April and sampled an area, approximately 160 km cross-shore by 170 km alongshore, in the CENCAL domain as shown in Figure 13. Each leg consisted of a series of three parallel transects directed alongshore, separated by roughly 80 km and along which hydrographic stations were occupied every 18.5 km. In addition, there were three diagonal transects and tracks to and from the domain.

DATA ACQUISITION

Data acquired during OPTOMA4 include XBT and CTD profiles and continuous 2 m thermalsalinograph measurements. Bucket surface temperature and water samples for salinity were taken at every CTD station. These surface values

and those at 2 m were used for calibration purposes as well as contributions to the data base. Continuous meteorological data such as atmospheric pressure at a height of 2 m and wind speed and direction at a height of 20 m were also recorded. The XBT, CTD and continuous "underway" data were digitized using an HP 5328 frequency counter and a 40 channel digital voltmeter. The continuous data were averaged over one-minute intervals. All data were recorded, using an HP 9835 computer, on data cassettes and transferred ashore to the IBM 3033 mainframe computer for editing and processing.

Station positions were determined by Loran C fixes and are claimed to be accurate to within about 0.1 km. Table 1 on page 5 summarizes the various sensors available on the R/V ACANIA and their accuracy. The bottle surface salinity samples were determined ashore by a Guildline Model 8400 "Autosal" salinometer with an accuracy of $\pm$0.003 ppt.

DATA PROCESSING

Data processing, such as estimating depth profiles for the XBT temperature profiles based on the XBT's descent speed, and conversion of CTD conductivity to salinity using the algorithm given in Lewis and Perkin (1981), was carried out on the IBM 3033 at the Naval Postgraduate School. The data were then edited by removing obvious salinity spikes and eliminating cast failures that were not identified during the cruise. Approximately 91% of casts were retained in the data set of Leg I and 94% in the data set of Leg II. The average difference between the surface salinity values from the bottle samples and the CTD's was less than 0.01 ppt for each leg, so no correction was made to the CTD salinity values. The CTD data were interpolated to 5 m intervals and then up and down casts were averaged.

The data have been transferred on digital tape to the National Oceanographic Data Center in Washington, DC.

DATA PRESENTATION

The cruise track, station locations (with XBT's and CTD's identified) and station numbers are shown in the first three figures of each of the next two sections, which present the data from Leg I and Leg II, respectively. These figures are followed by a listing of the stations, with their coordinates, the date and time at which the station was occupied, and the surface information obtained at the station.

Vertical profiles of temperature from the XBT casts are shown in staggered fashion. The location of these profiles may be found by reference to the various maps of the cruise track. Transect extremes are identified as nearly as possible. The first profile on each plot is shown with its temperature unchanged; to each subsequent profile an appropriate multiple of 5C has been added. Vertical profiles from the CTD's follow. Profiles of temperature are staggered by 5C and those of salinity by 4 ppt.

Isotherms for each transect are shown in the next pages, followed by isopleths of temperature, salinity and sigma-t from the CTD's. Based on instrument accuracy and the vertical temperature gradient, it is estimated that depths of isotherms in the main thermocline are uncertain to $\pm$20m. The tick marks identify station positions and, again, the transect extremes are shown on these plots.

Each section includes mean profiles of temperature from the XBT's and temperature, salinity and sigma-t from the CTD's as well as a scatter diagram of the T-S pairs and the mean S(T) curve with the $\pm$ standard deviation envelope. The data presentation concludes with a plot of the mean N^2 (Brunt-Vaisala frequency squared) profile with $\pm$ the standard deviation. On the sigma-t and N^2 plots, the appropriate profiles derived from the mean temperature and mean salinity profiles are also shown.

Table 1: Scientific instruments aboard the R/V ACANIA

	Instrument	Variable	Sensor	Accuracy	Resolution
	Neil Brown CTD Mark IIIb	pressure	strain gage	1.6 db	0.025 db
		temperature	thermistor	0.005 C	0.0005 C
		conductivity	electrode cell	0.005 mmho	0.001 mmho
	Sippican BT	temperature	thermistor	0.2 C	
		depth	descent speed	greater of 4.6 m and 2% of depth	
*	Guildline Autosal	conductivity	electrode cell	0.003 ppt	0.0002 ppt
*	Amatek straza ADVP	velocity profiles to 100m	4 beam sonar	3 cm/sec relative to ship speed	3 cm/sec
*	Rosemount Sensor	sea surface temperature	platinum thermometer	0.05 C	0.005 C
	Sea-Bird Sensors	temperature	thermistor	0.003 C	0.0005 C
		conductivity at 2 meters	electrode cell	0.003 mmho	0.0005 mmho
	Rosemount Sensor	air temperature	thermometer	0.01 C	
	Kavolico Barometer	atmospheric pressure	pressure transducer	1.5 mb	0.1 mb
*	1200 EPS Hygrometer	dew point	condensation temp. sensor	0.2 C	0.02 C
	Meteorology Res. Inc.	wind speed	anemometer	0.15 mph or 1%	
	Meteorology Res. Inc.	wind direction	vane	2.5 degrees	
	Internav LC408 LORAN C	position	two chain LORAN receiver	100 meters	10 meters
	Motorola Miniranger	position	microwave transponders	4 meters	2 meters

* Not operating on the OPTOMA4 cruise.

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SECTION 1

OPTOMA4 Leg I

26 March - 1 April 1983

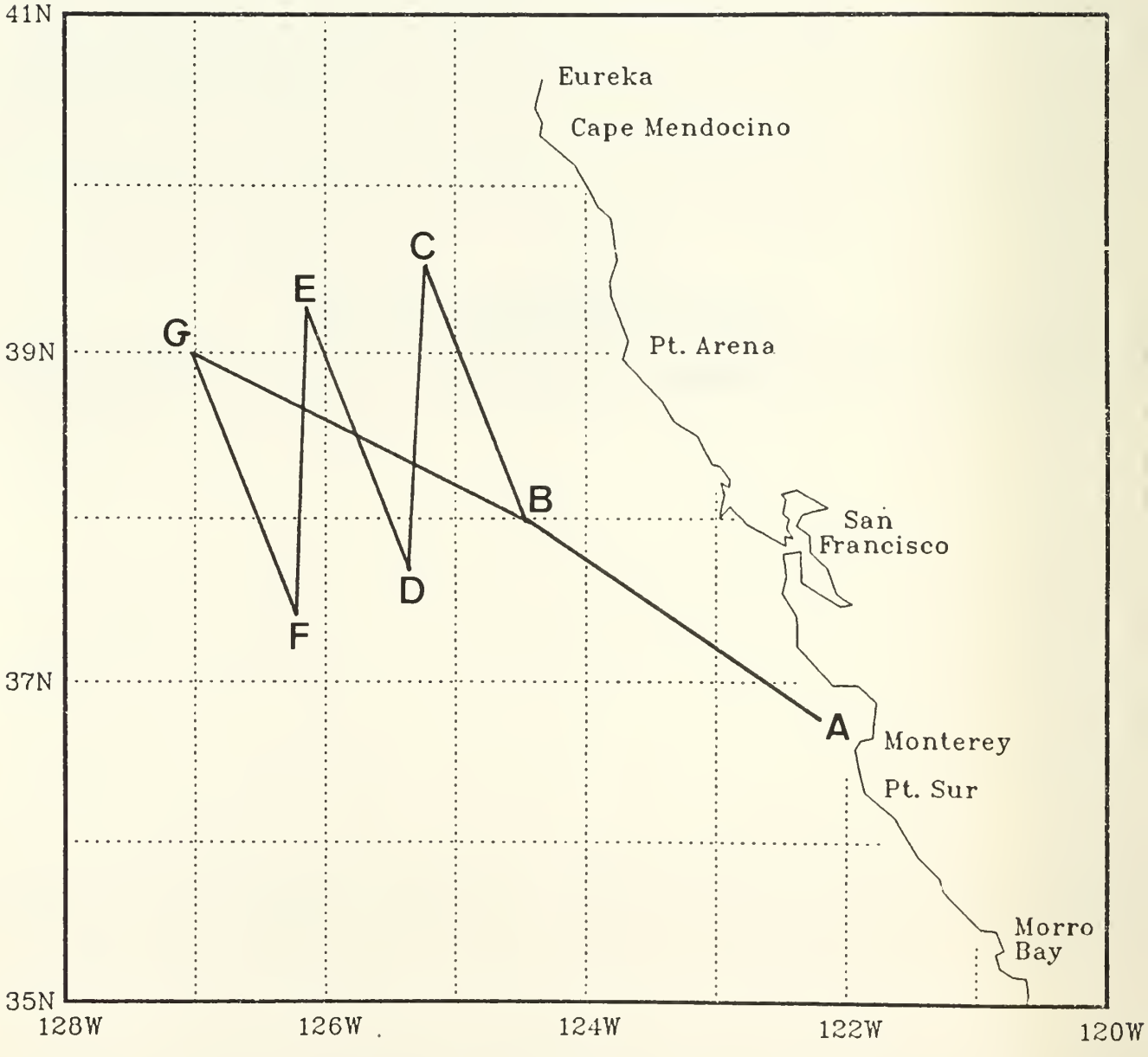


Figure 2: Cruise track for OPTOMA4, Leg I with transect extremes identified by letter.

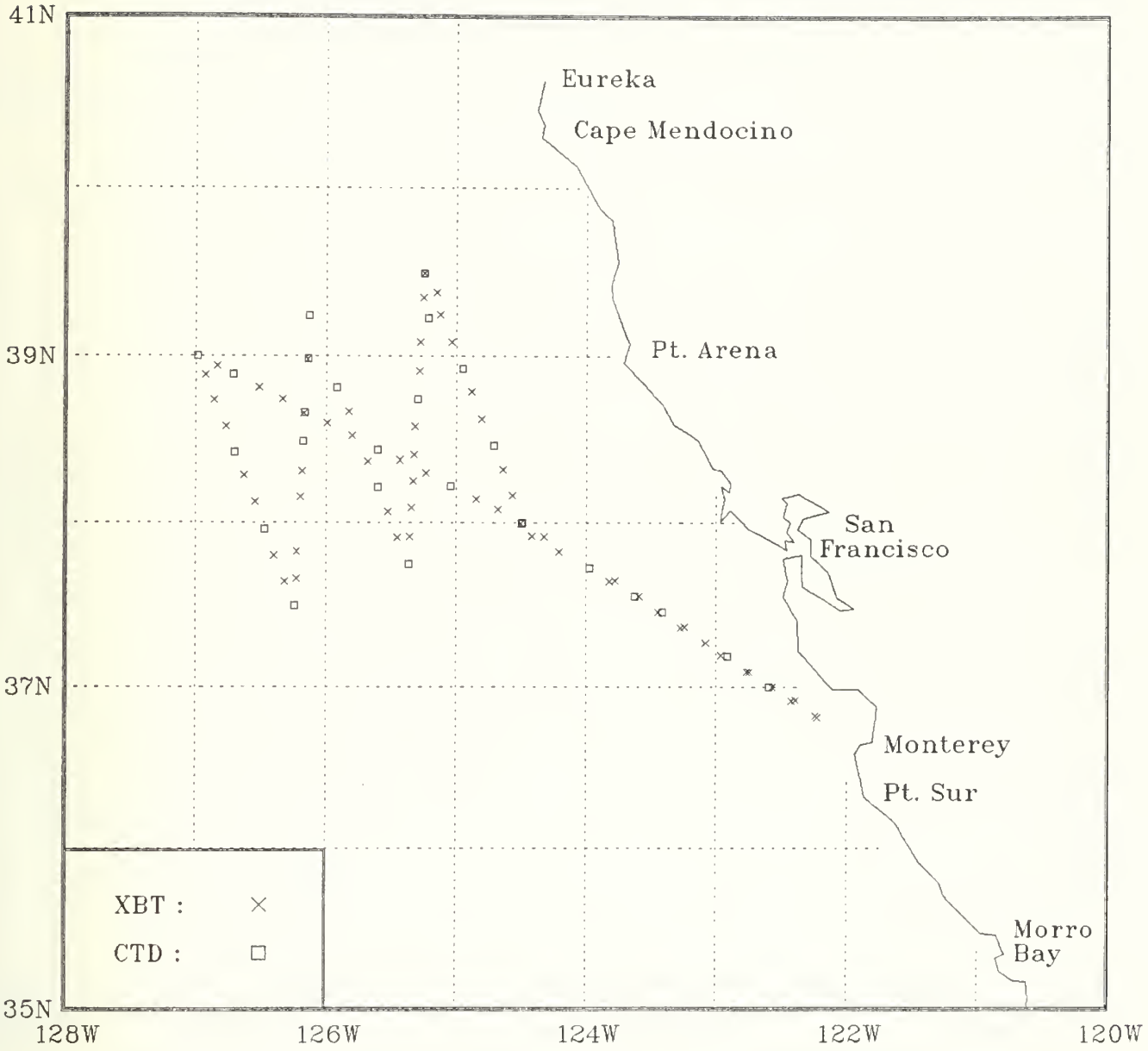


Figure 3: XBT and CTD locations for OPTOMA4, Leg I.

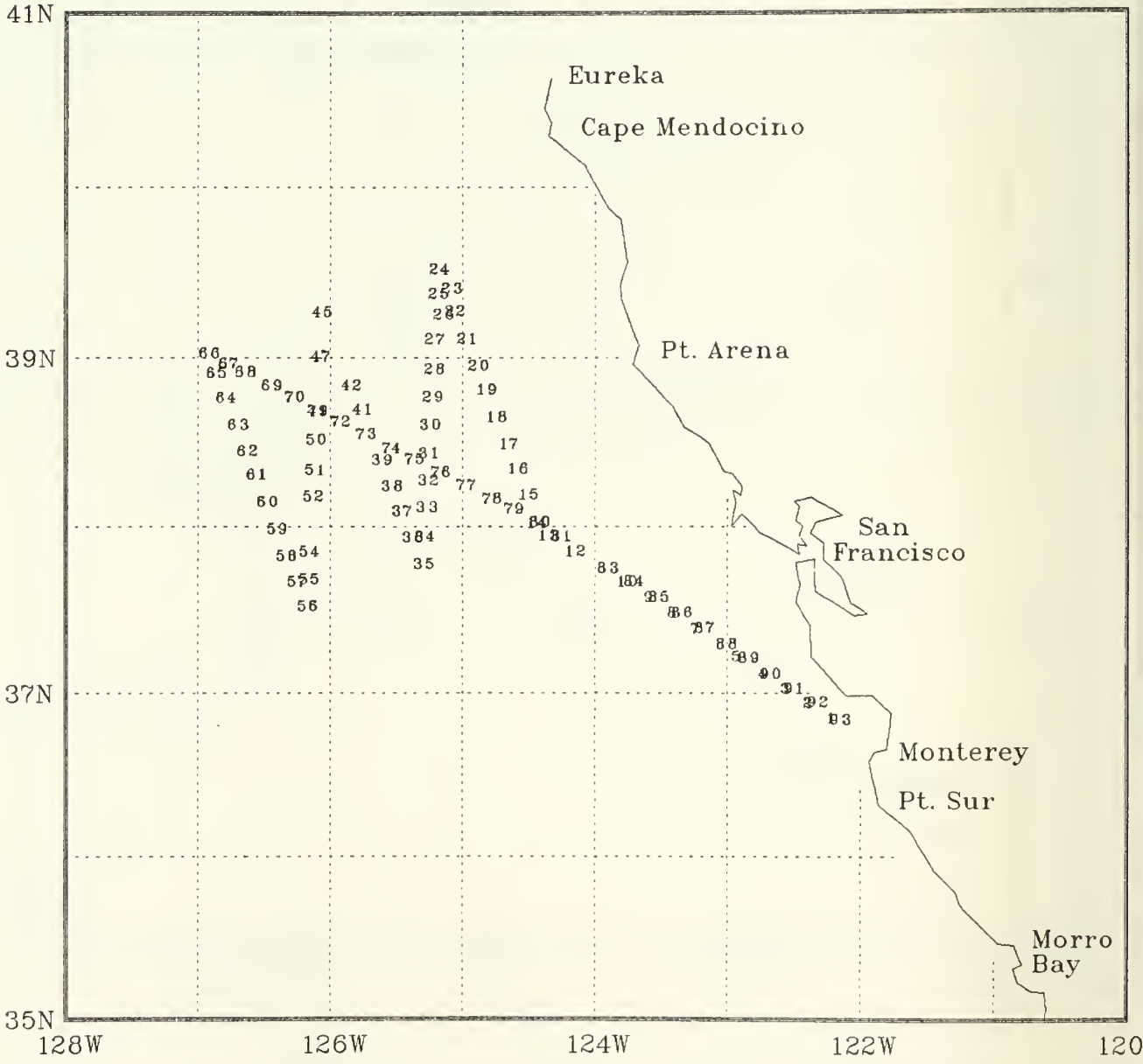


Figure 4: Station numbers for OPTOMA4, Leg I.

Table 2: Leg I Station Listing

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
1	XBT	83085	2006	36.49	122.14	13.7			
2	XBT	83085	2121	36.55	122.25	13.9			
3	CTD	83085	2238	37.00	122.35	13.5	32.43	13.6	32.47
4	XBT	83086	8	37.06	122.46	13.1			
5	XBT	83086	128	37.12	122.58	13.1			
7	XBT	83086	334	37.22	123.16	13.0			
8	XBT	83086	446	37.28	123.27	13.0			
9	CTD	83086	559	37.33	123.38	12.6	32.57	12.8	32.57
10	XBT	83086	818	37.39	123.49	13.8			
12	XBT	83086	1325	37.50	124.13	12.9			
13	XBT	83086	1500	37.55	124.25	13.0			
14	CTD	83086	1649	38.00	124.30	13.1	33.04	13.1	33.03
14	XBT	83086	1724	38.00	124.30	13.2			
15	XBT	83086	1854	38.10	124.34	13.0			
16	XBT	83086	2005	38.19	124.39	13.1			
17	CTD	83086	2111	38.28	124.43	13.0	32.88	12.9	32.85
18	XBT	83086	2253	38.38	124.49	12.6			
19	XBT	83087	10	38.47	124.53	12.6			
20	CTD	83087	120	38.56	124.57	12.6	32.73	12.6	32.78
21	XBT	83087	308	39.05	125.02	12.3			
22	XBT	83087	429	39.15	125.08	12.6			
23	XBT	83087	531	39.23	125.09	12.2			
24	CTD	83087	705	39.30	125.15	12.2	32.71	12.1	32.74
24	XBT	83087	744	39.30	125.15	12.2			
25	XBT	83087	842	39.21	125.15	12.8			
26	CTD	83087	942	39.14	125.13	12.5	32.80	12.2	32.80
27	XBT	83087	1114	39.05	125.17	12.3			
28	XBT	83087	1232	38.55	125.17	12.5			
29	CTD	83087	1348	38.45	125.18	12.4	32.77	12.2	32.79
30	XBT	83087	1526	38.35	125.19	12.3			
31	XBT	83087	1642	38.25	125.20	12.3			
32	XBT	83087	1812	38.15	125.20	13.1			
33	XBT	83087	1935	38.05	125.21	13.1			
34	XBT	83087	2055	37.55	125.21	13.3			
35	CTD	83087	2208	37.45	125.22	13.5	33.10	13.5	33.08
36	XBT	83088	44	37.55	125.27	13.1			
37	XBT	83088	158	38.04	125.32	13.1			
38	CTD	83088	307	38.13	125.36	13.2	33.02	13.2	33.03
39	XBT	83088	436	38.22	125.41	12.9			
41	XBT	83088	744	38.40	125.50	12.2			
42	CTD	83088	848	38.49	125.55	12.4	32.84	12.5	32.82
45	CTD	83088	1231	39.15	126.08	11.7	32.66	11.9	32.63
47	CTD	83088	1641	38.59	126.08	12.3	32.69	12.2	32.86
47	XBT	83088	1658	38.59	126.09	12.4			
49	XBT	83088	2045	38.40	126.10	12.1			

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
50	CTD	83088	2224	38.30	126.11	12.7	32.94	12.9	32.91
51	XBT	83089	35	38.19	126.11	12.7			
52	XBT	83089	155	38.09	126.12	12.7			
54	XBT	83089	509	37.50	126.14	13.1			
55	XBT	83089	638	37.40	126.14	13.2			
56	CTD	83089	753	37.30	126.15	12.8	32.86	12.9	32.85
57	XBT	83089	1009	37.39	126.19	12.6			
58	XBT	83089	1121	37.48	126.24	12.8			
59	CTD	83089	1233	37.58	126.28	12.6	32.86	12.7	32.83
60	XBT	83089	1410	38.07	126.33	12.7			
61	XBT	83089	1521	38.17	126.38	12.9			
62	CTD	83089	1626	38.26	126.42	12.5	32.83	12.8	32.87
63	XBT	83089	1754	38.35	126.46	12.5			
64	XBT	83089	1900	38.44	126.52	11.8			
65	XBT	83089	2004	38.53	126.56	12.0			
66	CTD	83089	2056	39.00	126.59	12.0	32.81	12.4	32.83
67	XBT	83089	2251	38.57	126.50	12.7			
68	CTD	83089	2336	38.54	126.43	12.2	32.84	12.5	32.83
69	XBT	83090	106	38.49	126.31	12.5			
70	XBT	83090	205	38.45	126.20	12.6			
71	CTD	83090	309	38.40	126.10	12.3	32.86	12.4	32.87
72	XBT	83090	428	38.36	126.00	12.8			
73	XBT	83090	533	38.32	125.48	12.8			
74	CTD	83090	645	38.27	125.36	12.8	32.90	12.7	32.87
75	XBT	83090	846	38.23	125.26	12.7			
76	XBT	83090	954	38.18	125.14	12.5			
77	CTD	83090	1104	38.13	125.03	12.5	32.77	12.6	32.77
78	XBT	83090	1235	38.08	124.51	13.1			
79	XBT	83090	1329	38.05	124.41	13.7			
80	CTD	83090	1432	38.00	124.30	13.2	32.94	13.2	32.96
81	XBT	83090	1638	37.55	124.20	13.7			
83	CTD	83090	1849	37.44	123.59	13.1	32.91	13.1	32.92
84	XBT	83090	2023	37.39	123.47	13.4			
85	XBT	83090	2136	37.33	123.35	13.8			
86	CTD	83090	2247	37.27	123.25	13.3	31.42	13.4	31.43
87	XBT	83091	29	37.22	123.15	13.5			
88	XBT	83091	130	37.16	123.05	13.5			
89	CTD	83091	231	37.11	122.55	13.5	31.71	13.5	31.70
91	XBT	83091	454	37.00	122.34	14.1			
92	XBT	83091	558	36.55	122.24	14.0			
93	XBT	83091	705	36.49	122.13	13.8			

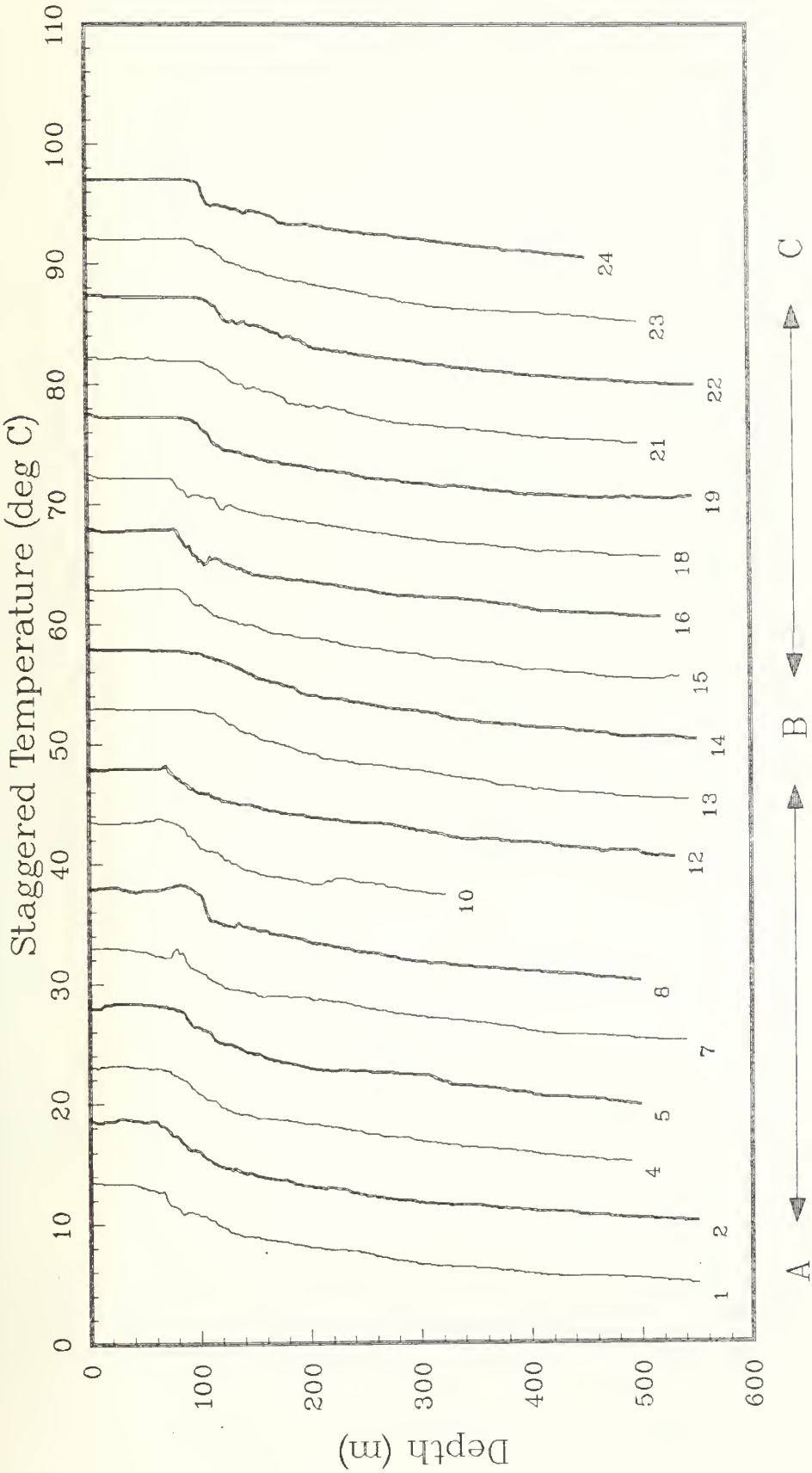
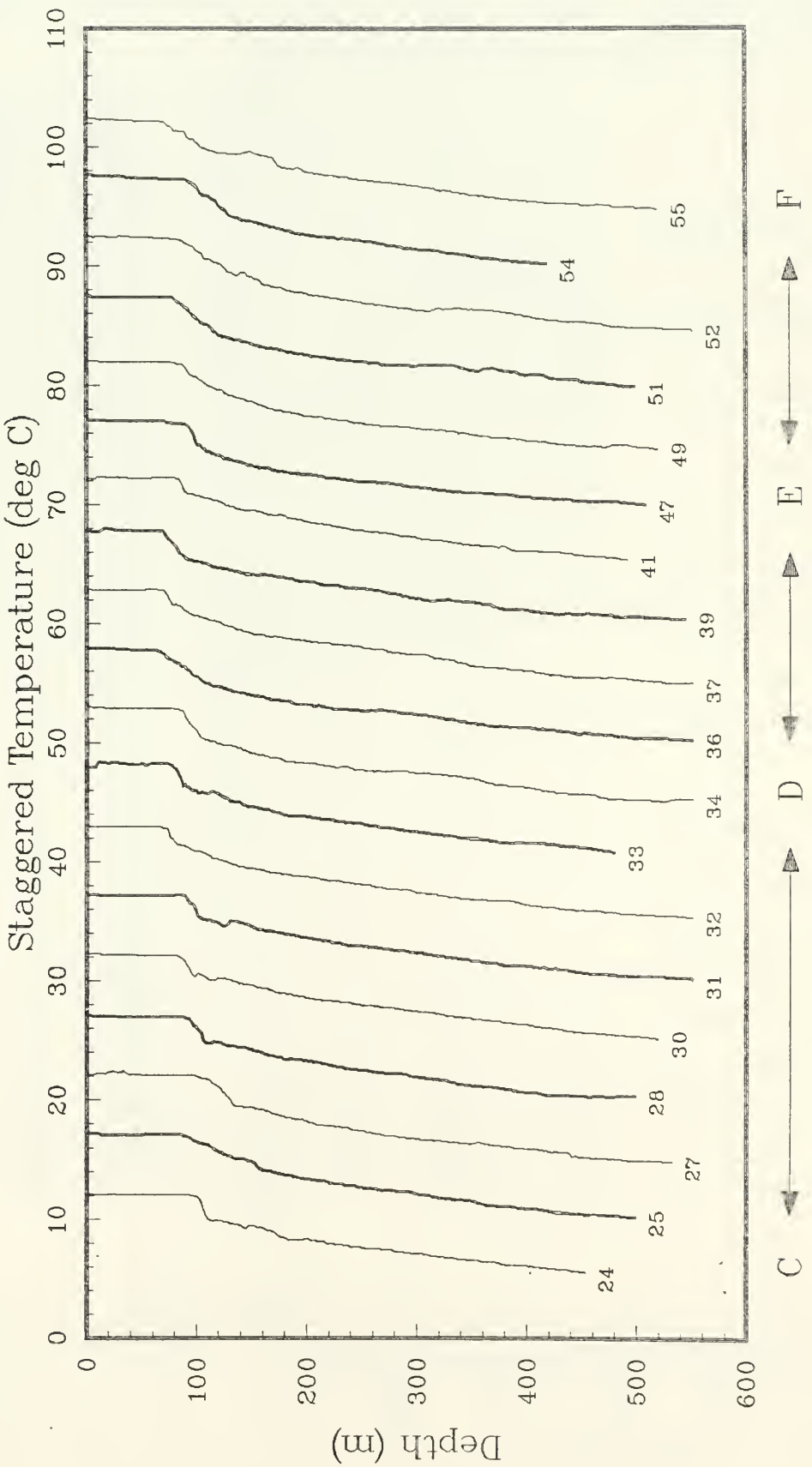


Figure 5(a): Staggered temperature profiles from the XBT's. Profiles are staggered by a multiple of 5C (OPTOMA4, Leg I).


Staggered Temperature (deg C)
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10
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Depth (m)
0
100
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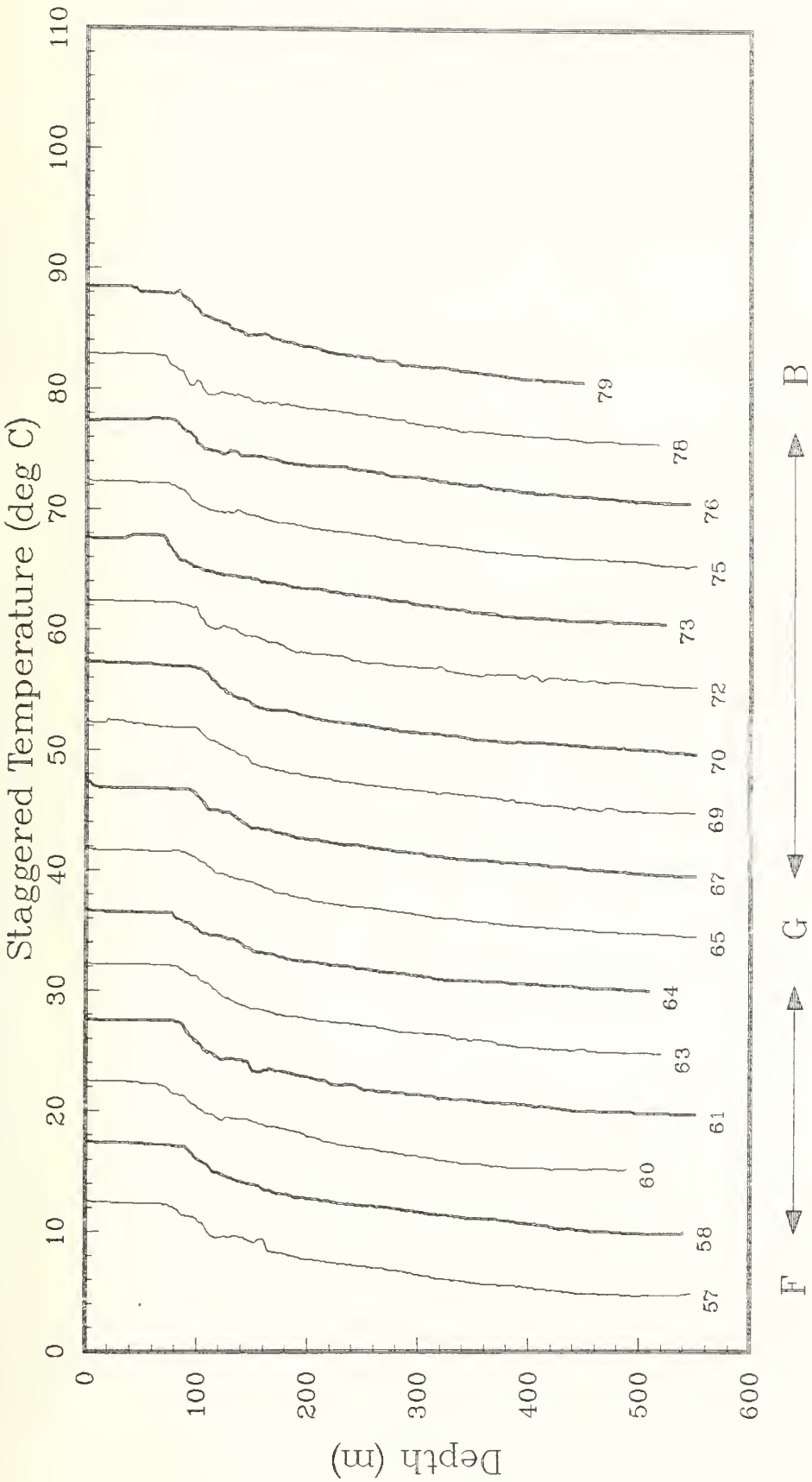
Figure 5(b)


Staggered Temperature (deg C)
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90
100
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Depth (m)
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600
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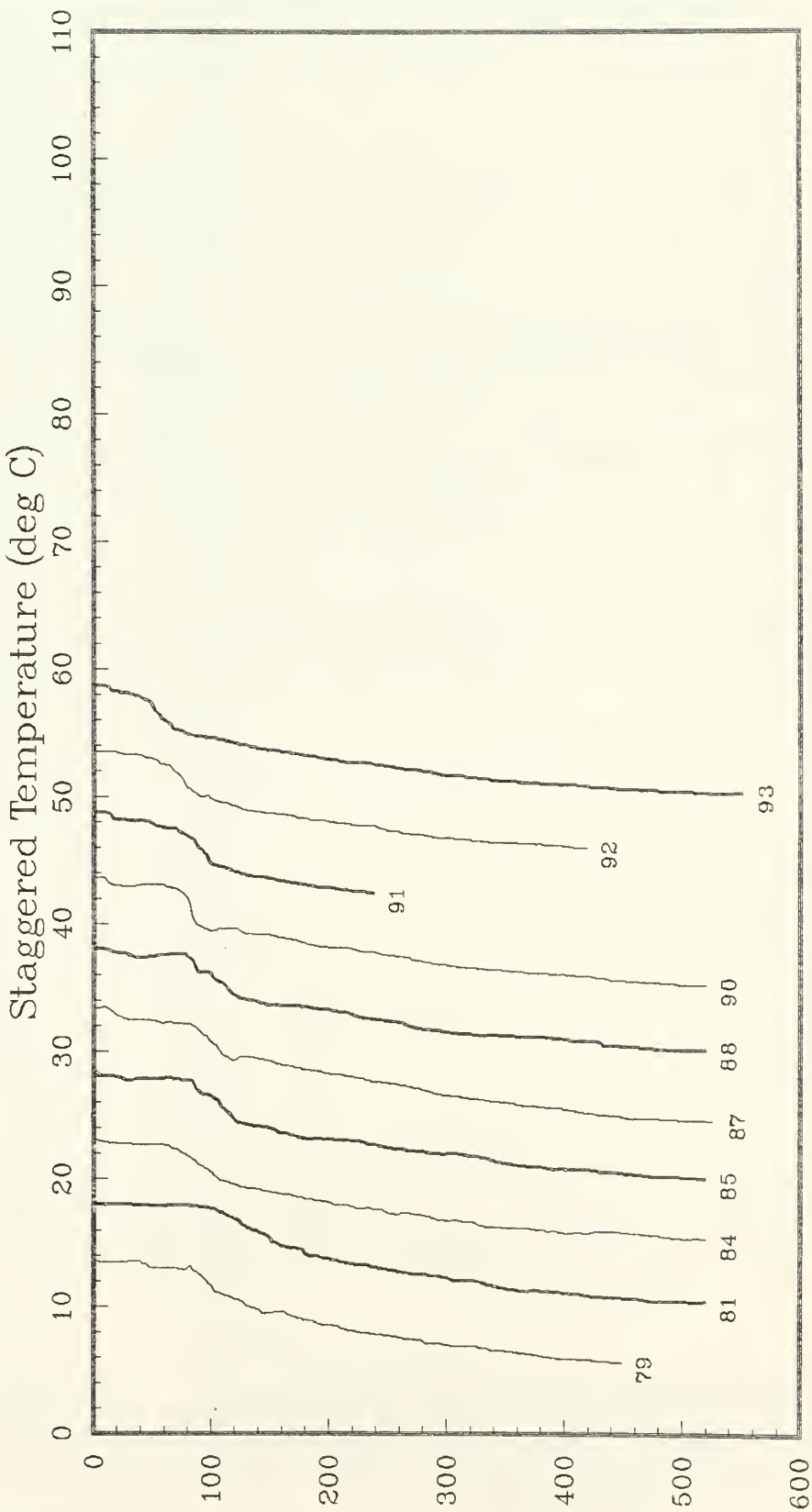
Figure 5(c)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0
10
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30
40
50
60
70
80
90
100
110
Depth (m)
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A

Figure 5(d)

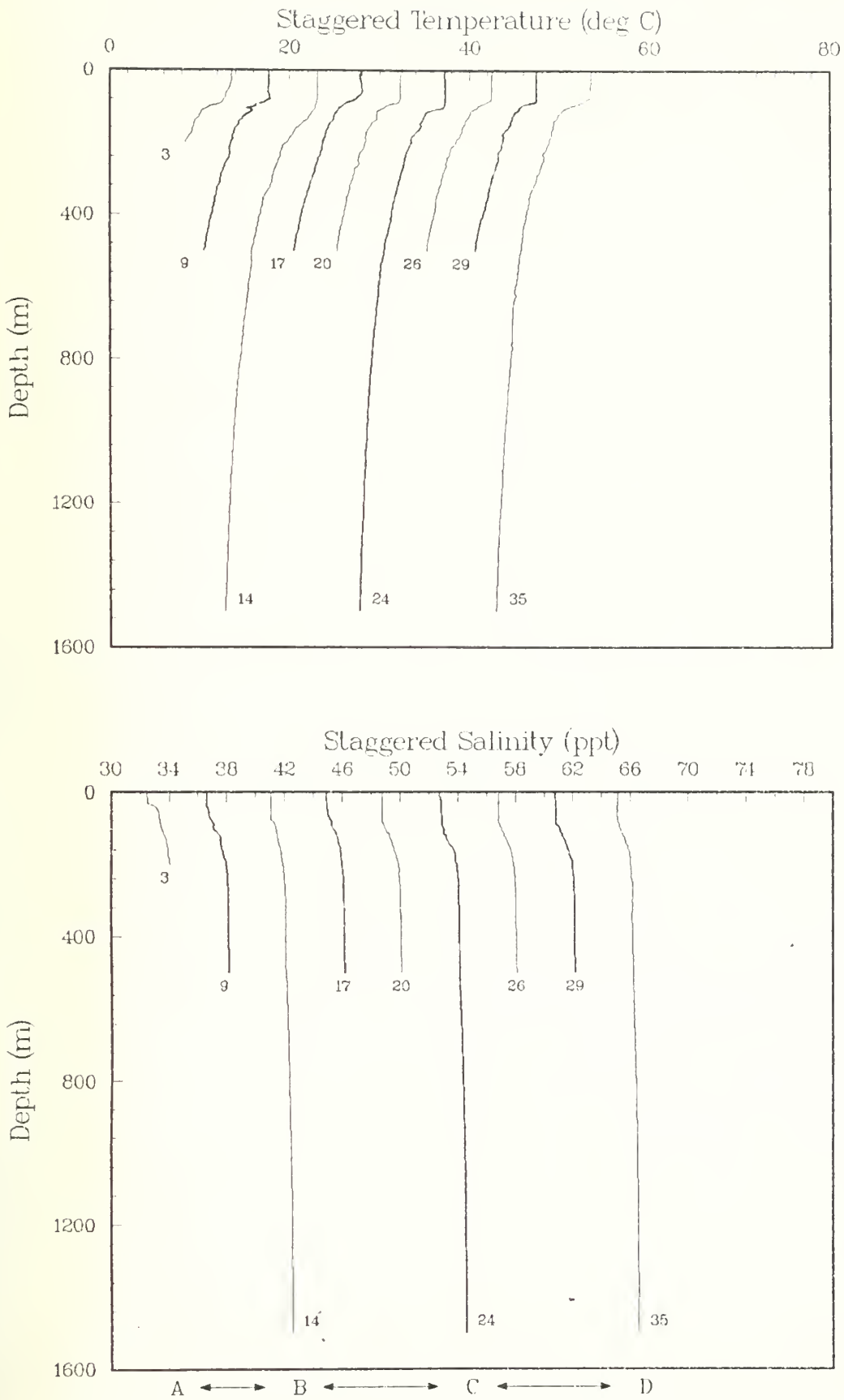
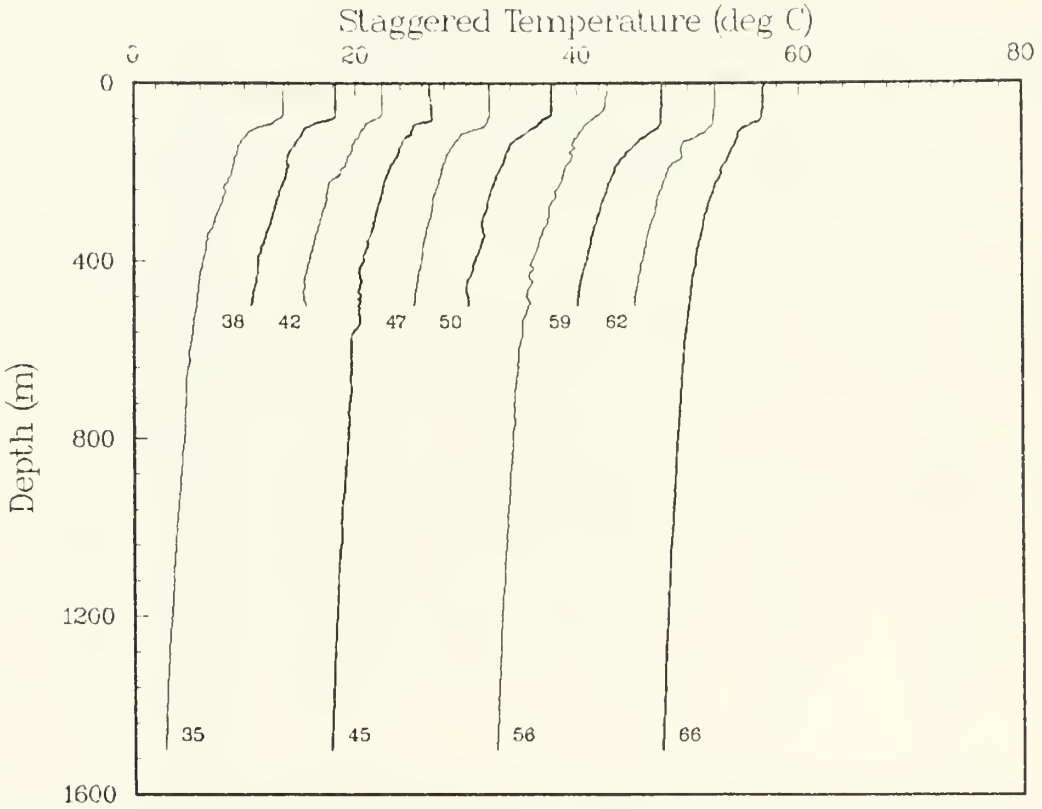


Figure 6(a): CTD temperature profiles, staggered by multiples of 5C, and salinity profiles, staggered by multiples of 4 ppt (OPTOMA4, Leg I).


Staggered Temperature (deg C)
0
20
40
60
80
0
400
800
1200
1600
Depth (m)
38
42
47
50
59
62
35
45
56
66

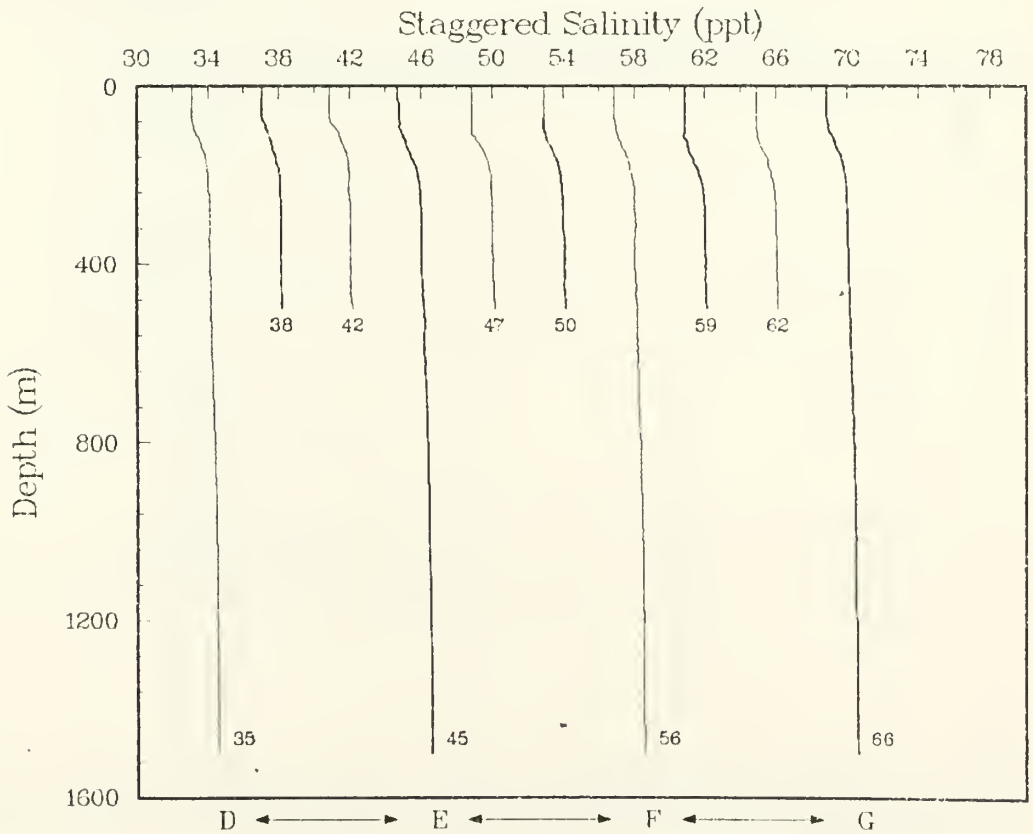

Staggered Salinity (ppt)
30
34
38
42
46
50
54
58
62
66
70
74
78
0
400
800
1200
1600
Depth (m)
38
42
47
50
59
62
35
45
56
66
D
E
F
G

Figure 6(b).

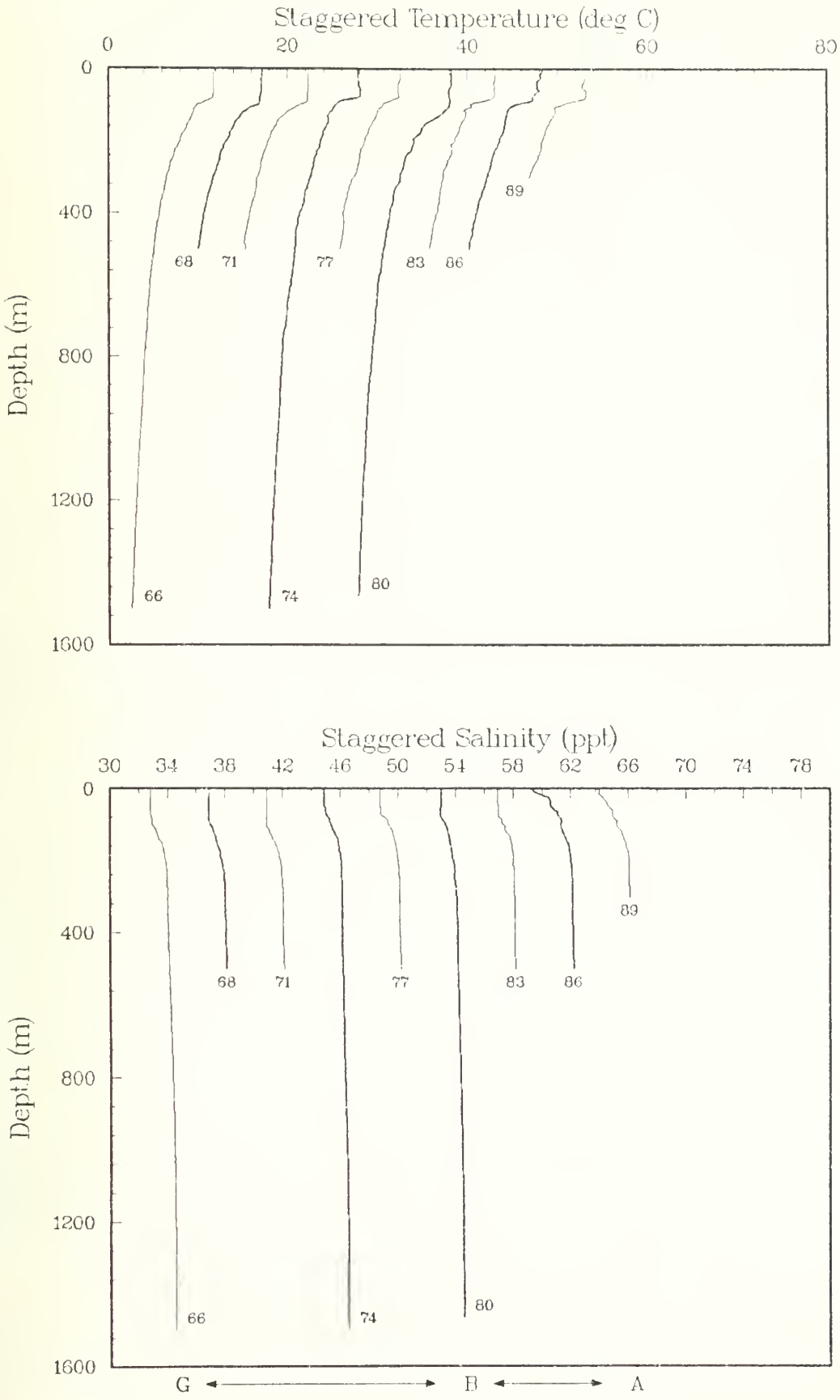

Staggered Temperature (deg C)
0
20
40
60
80
0
400
800
1200
1600
Depth (m)
68
71
77
83
86
89
66
74
80
Staggered Salinity (ppl)
30
34
38
42
46
50
54
58
62
66
70
74
78
0
400
800
1200
1600
Depth (m)
68
71
77
83
86
89
66
74
80
G
B
A

Figure 6(c).

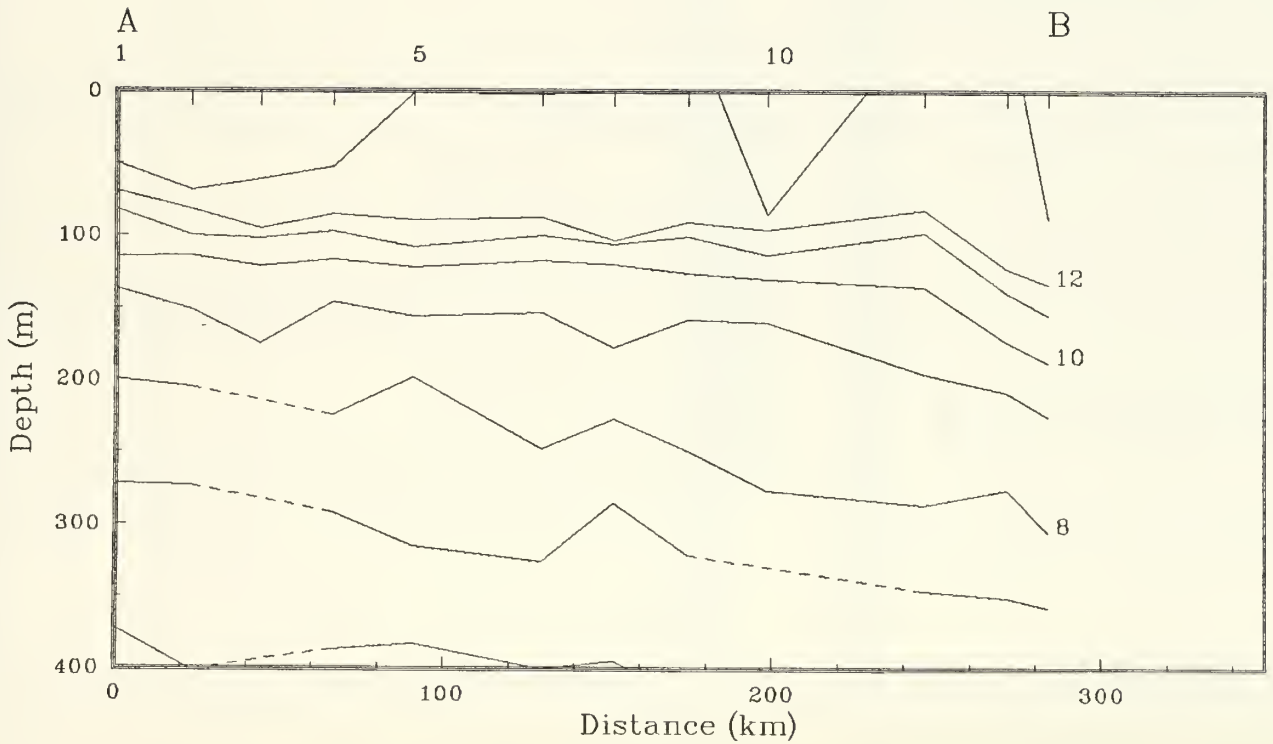


Figure 7(a): Isotherms from XBT's and CTD's. Tick marks along the upper horizontal axis show station positions. Some station numbers are given. Dashed lines are used if the cast was too shallow (OPTOMA4, Leg I).

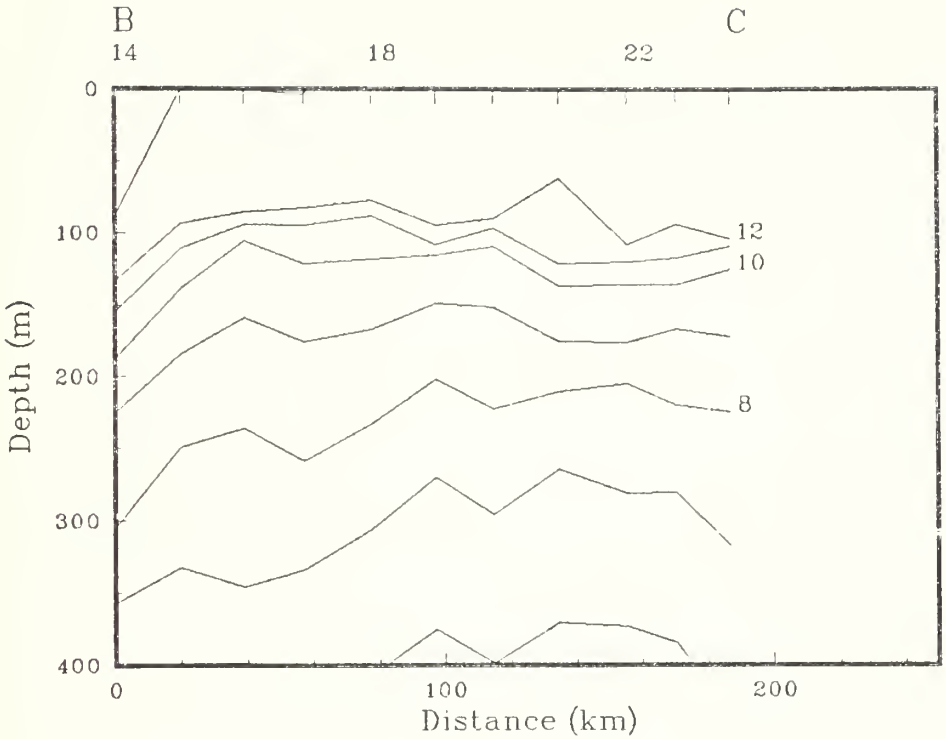


Figure 7(b)

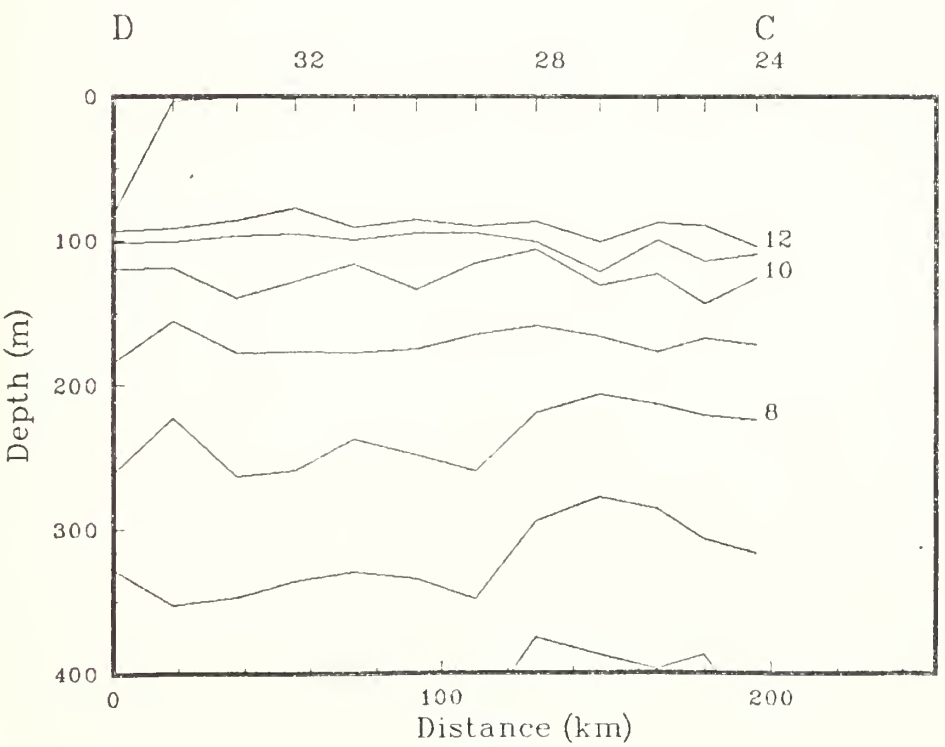


Figure 7(c)

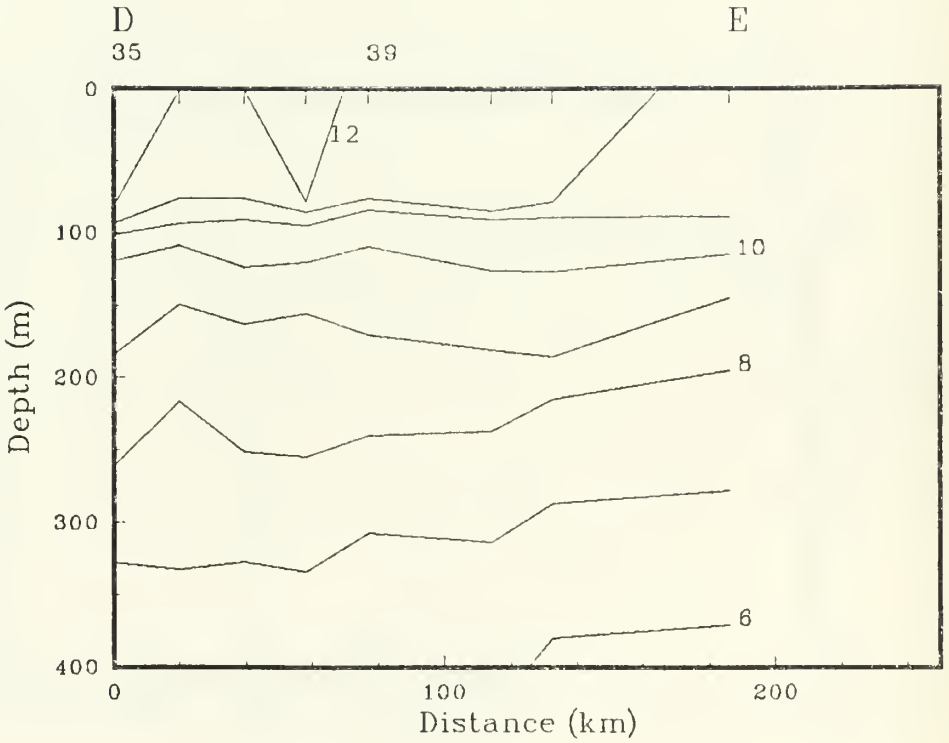


Figure 7(d)

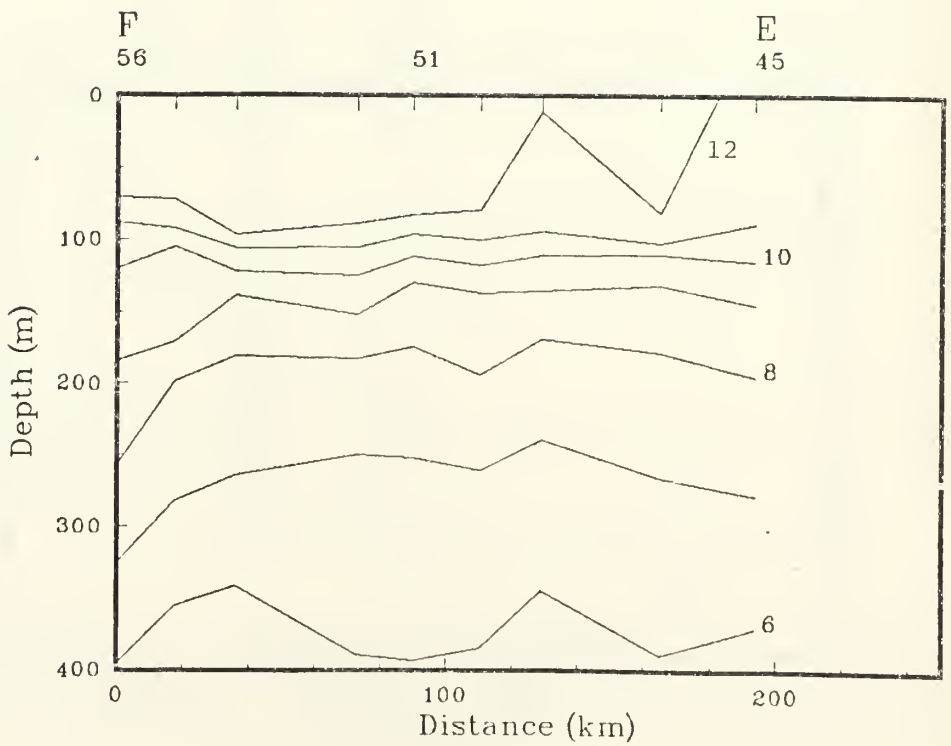


Figure 7(e)

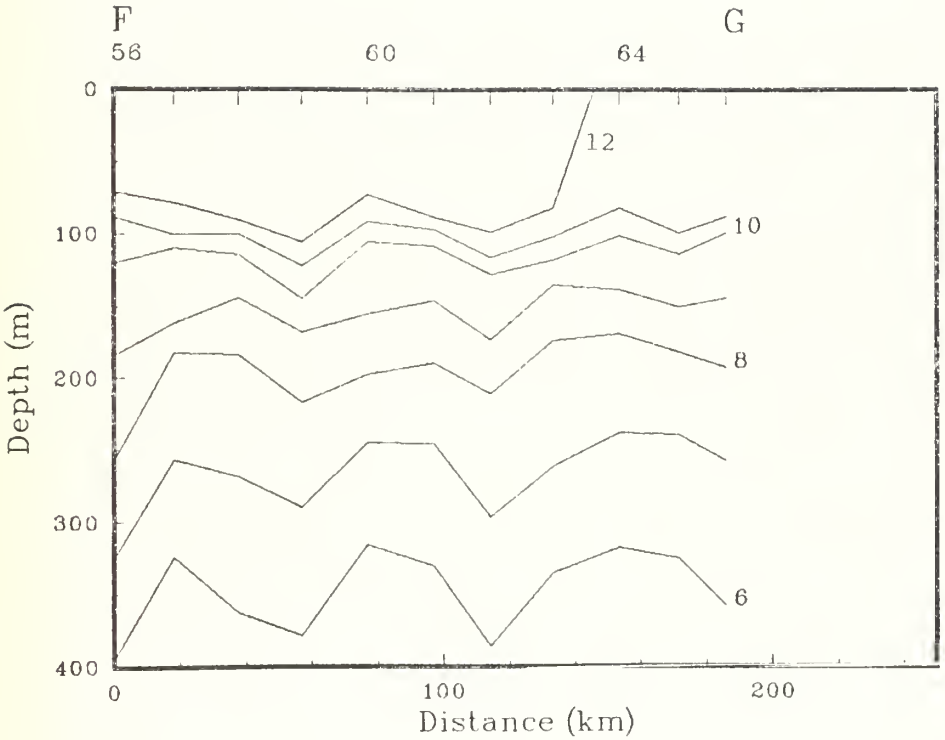

F
G
56
60
64
0
100
200
300
400
Depth (m)
12
10
8
6
0
100
200
Distance (km)

Figure 7(f)

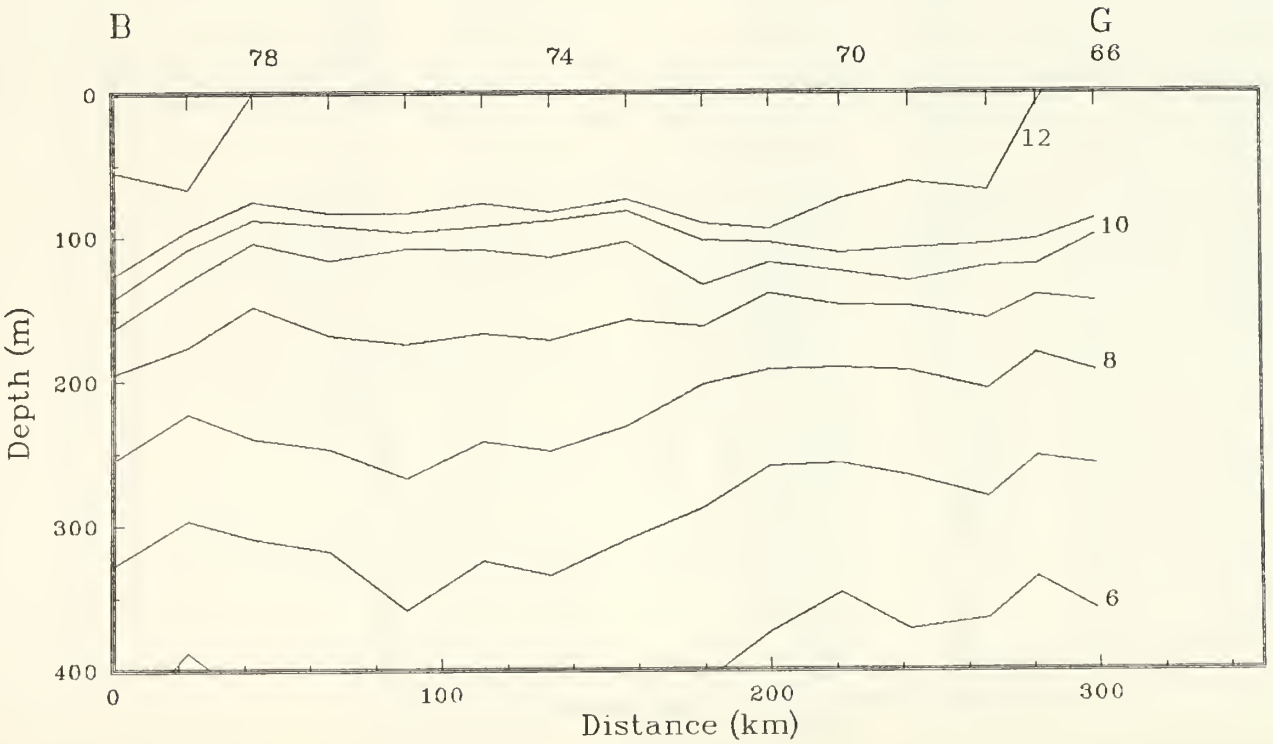

B
G
78
74
70
66
0
100
200
300
400
Depth (m)
12
10
8
6
0
100
200
300
Distance (km)

Figure 7(g)

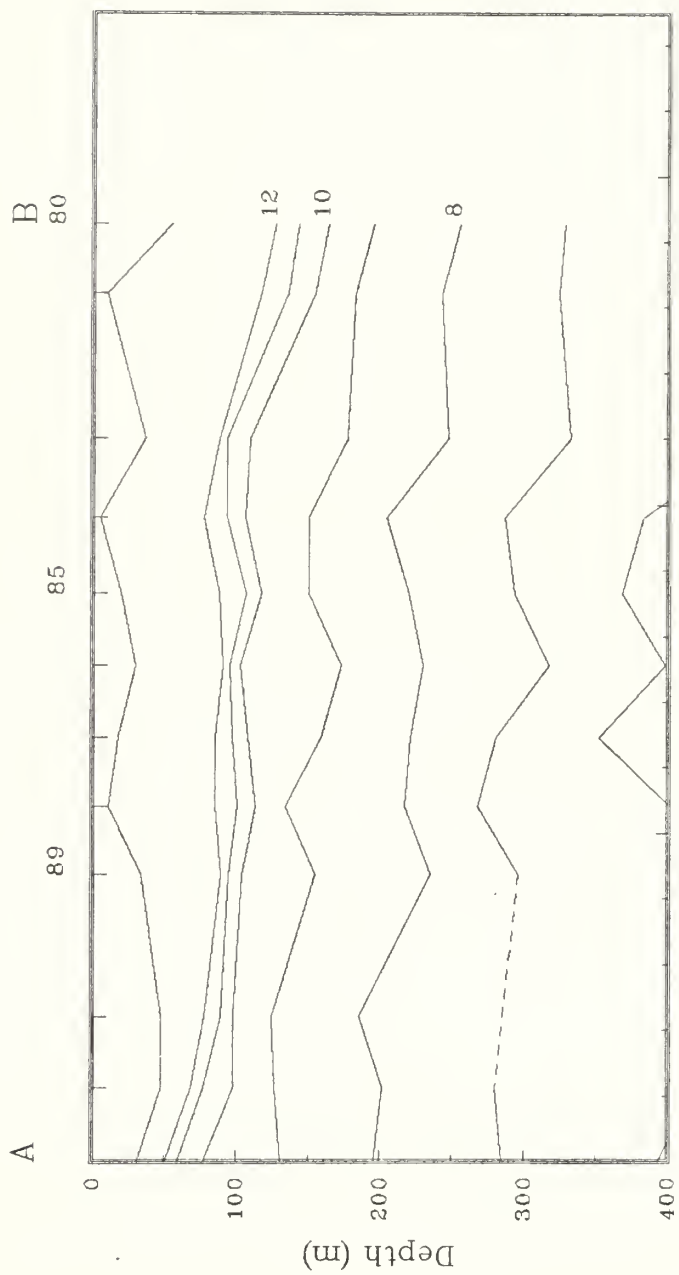

A
B
89
85
80
12
10
8
0
100
200
300
400
Depth (m)
0
100
200
300
Distance (km)

Figure 7(h)

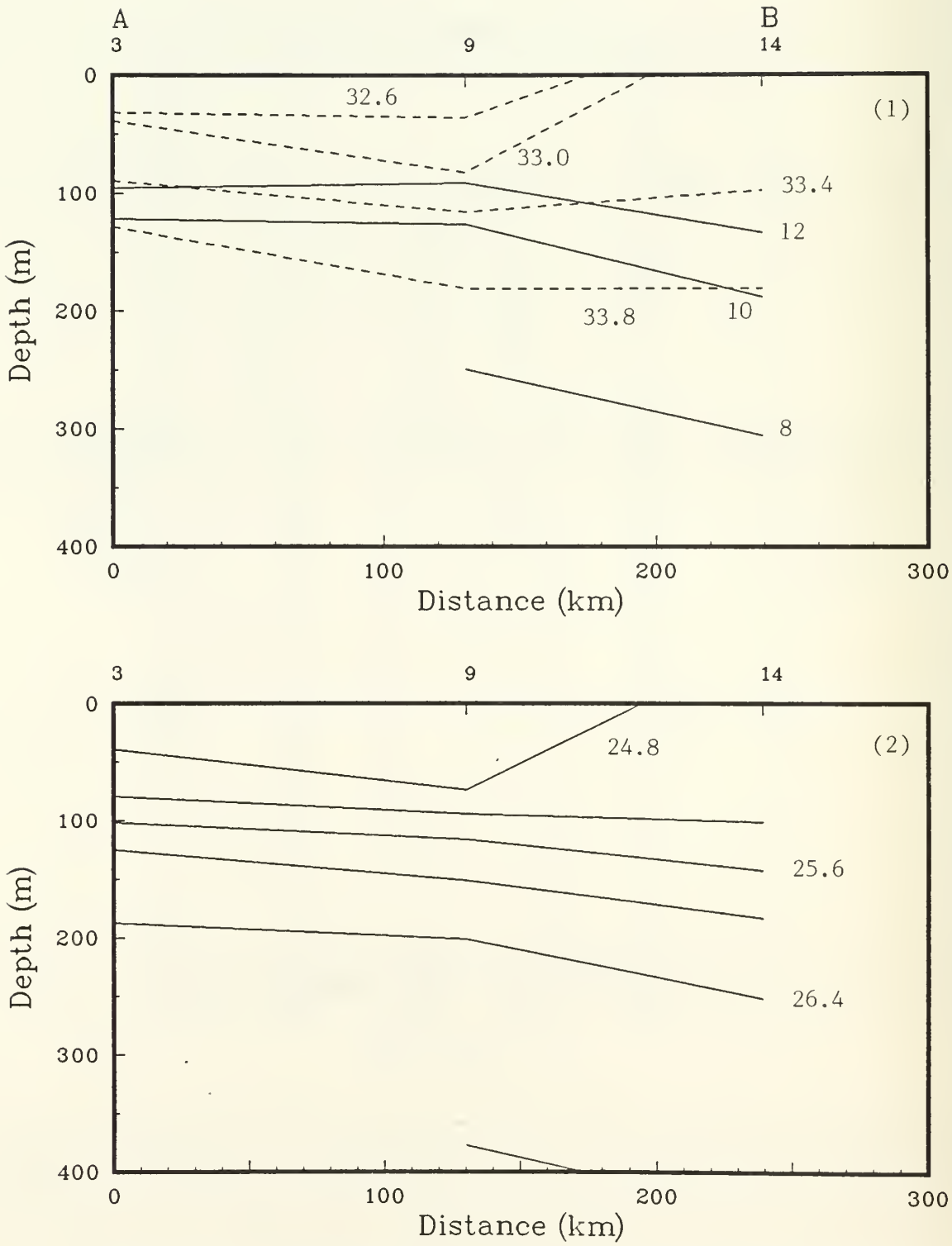


Figure 8(a): Isopleths of (1) temperature and salinity and (2) sigma-t from the CTD's (OPTOMA4, Leg I).

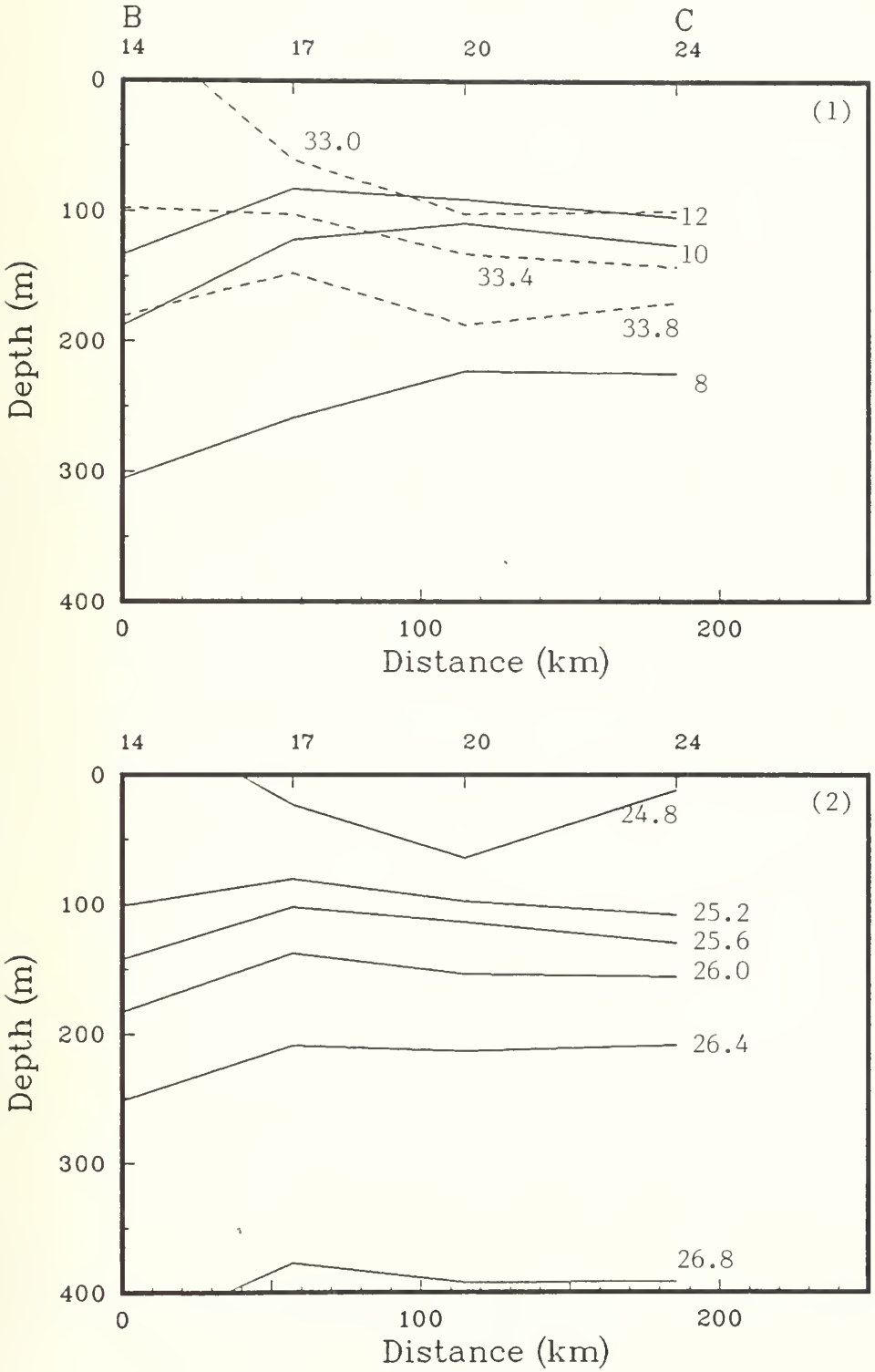
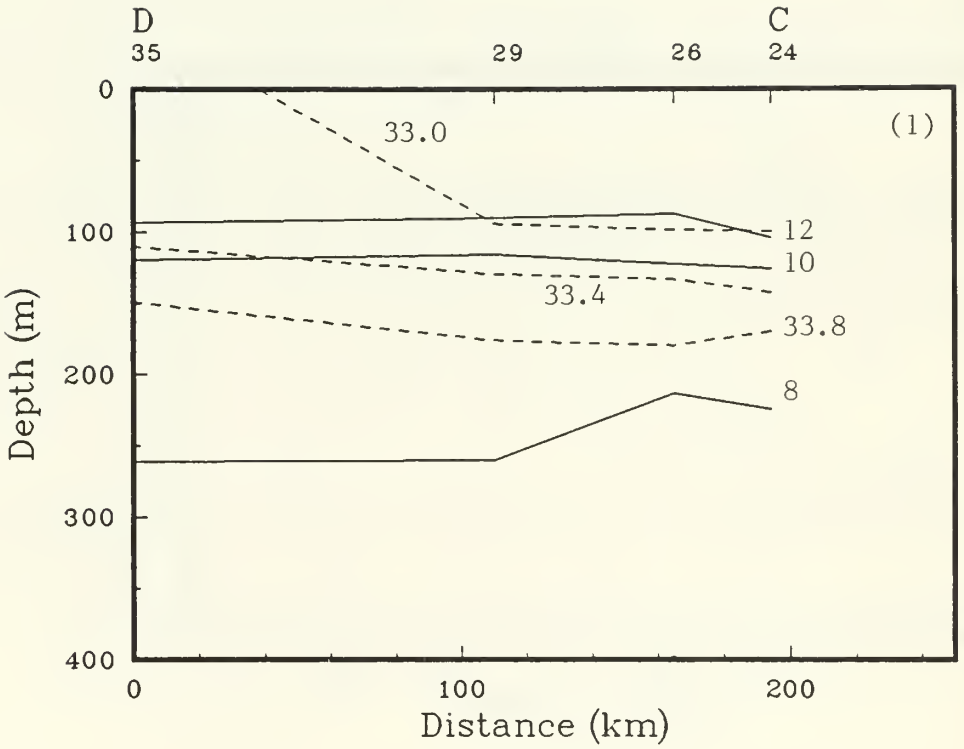

B
C
14
17
20
24
0
100
200
300
400
Depth (m)
(1)
33.0
12
10
33.4
33.8
8
0
100
200
Distance (km)
14
17
20
24
0
100
200
300
400
Depth (m)
(2)
24.8
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 8(b)


D
C
35
29
26
24
0
100
200
300
400
Depth (m)
33.0
(1)
12
10
33.4
33.8
8
0
100
200
Distance (km)

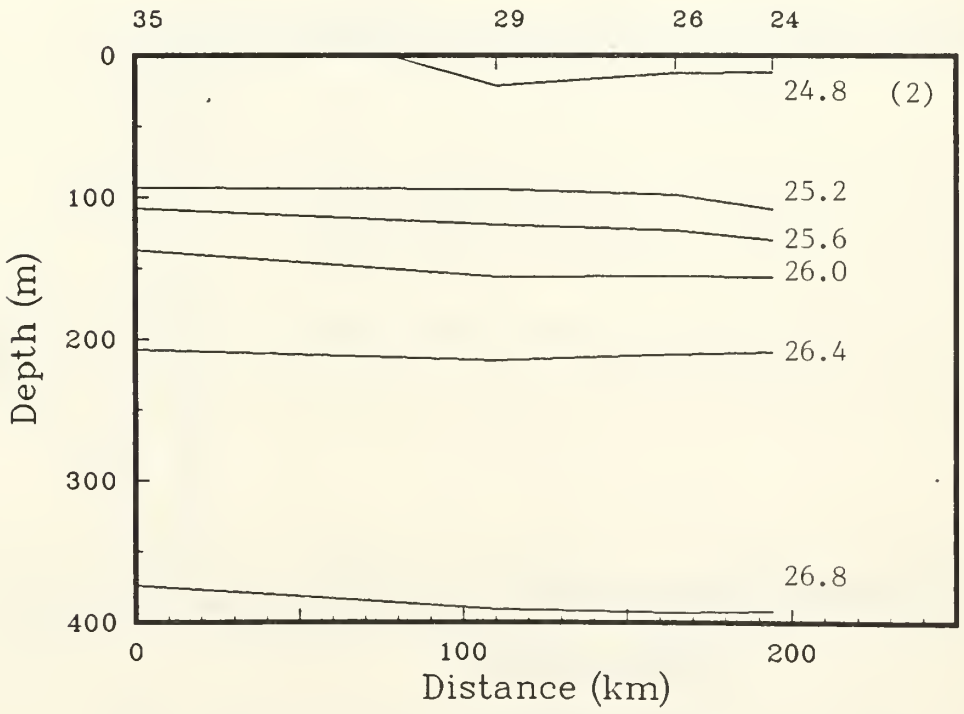

35
29
26
24
0
100
200
300
400
Depth (m)
24.8
(2)
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 8(c)

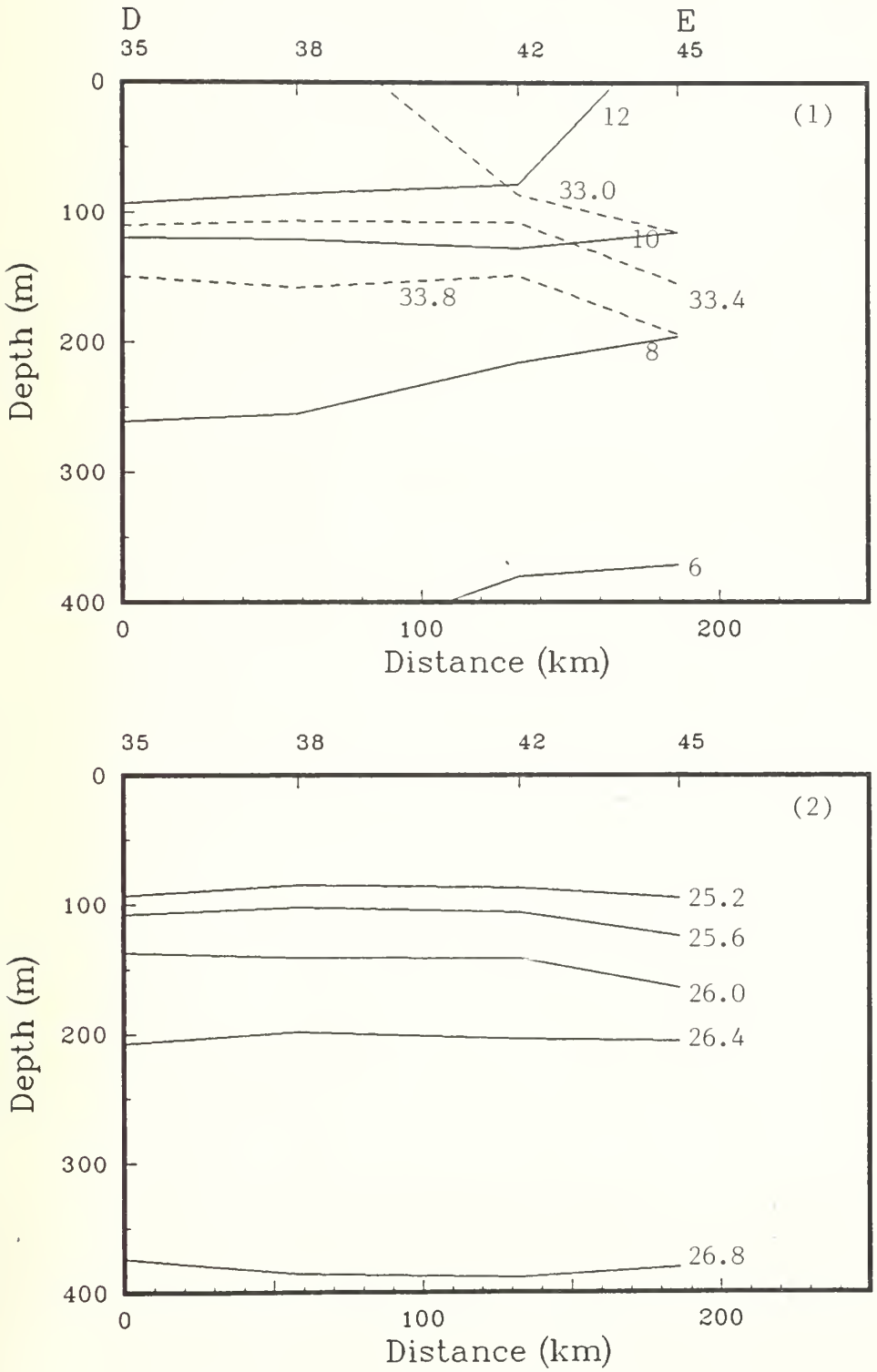

D
E
35
38
42
45
0
100
200
300
400
Depth (m)
12
(1)
33.0
10
33.8
33.4
8
6
0
100
200
Distance (km)
35
38
42
45
0
100
200
300
400
Depth (m)
(2)
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 8(d)

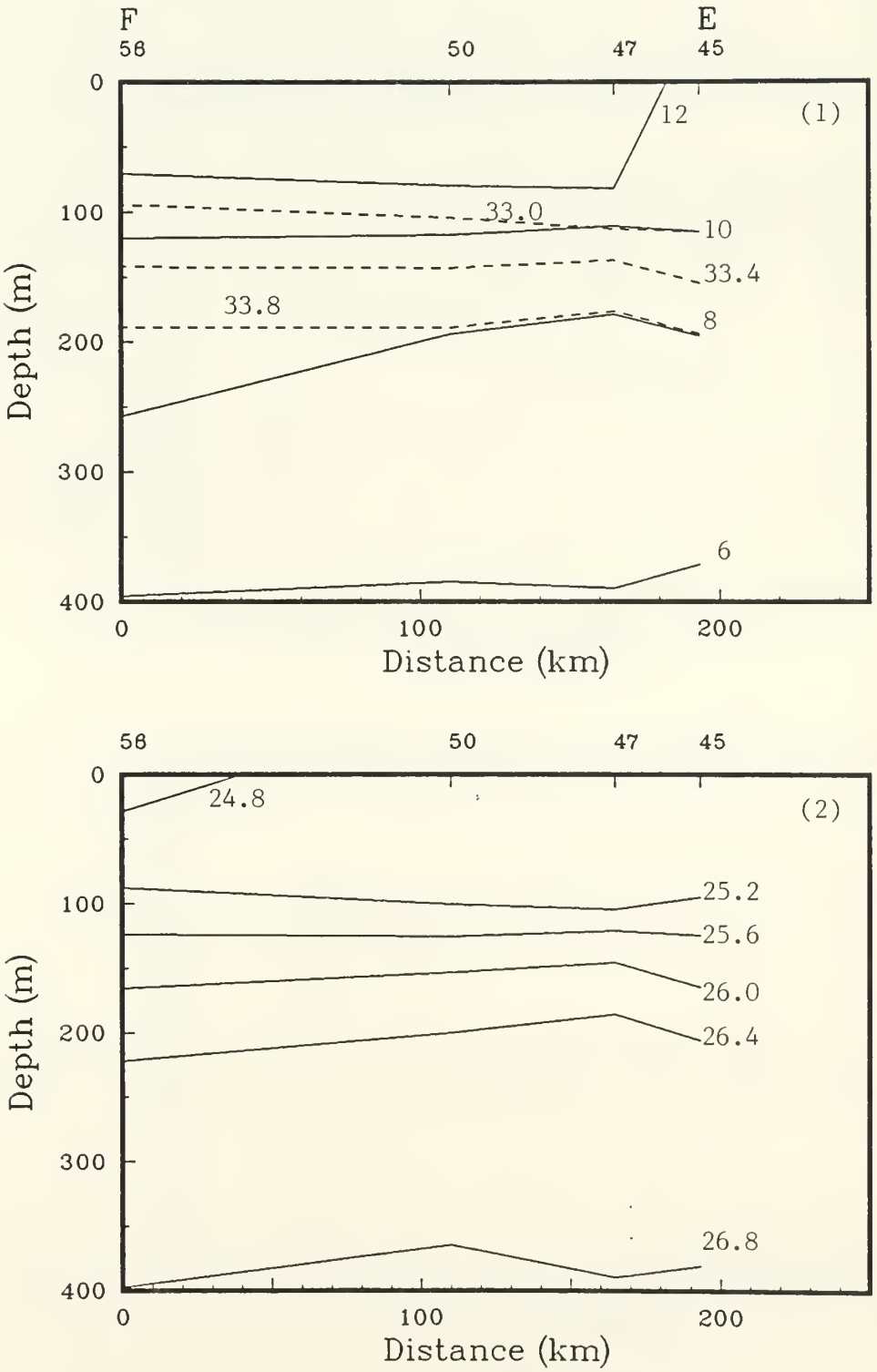

F
E
58
50
47
45
0
100
200
300
400
Depth (m)
12
(1)
33.0
10
33.4
33.8
8
6
0
100
200
Distance (km)
58
50
47
45
0
100
200
300
400
Depth (m)
24.8
(2)
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 8(e)

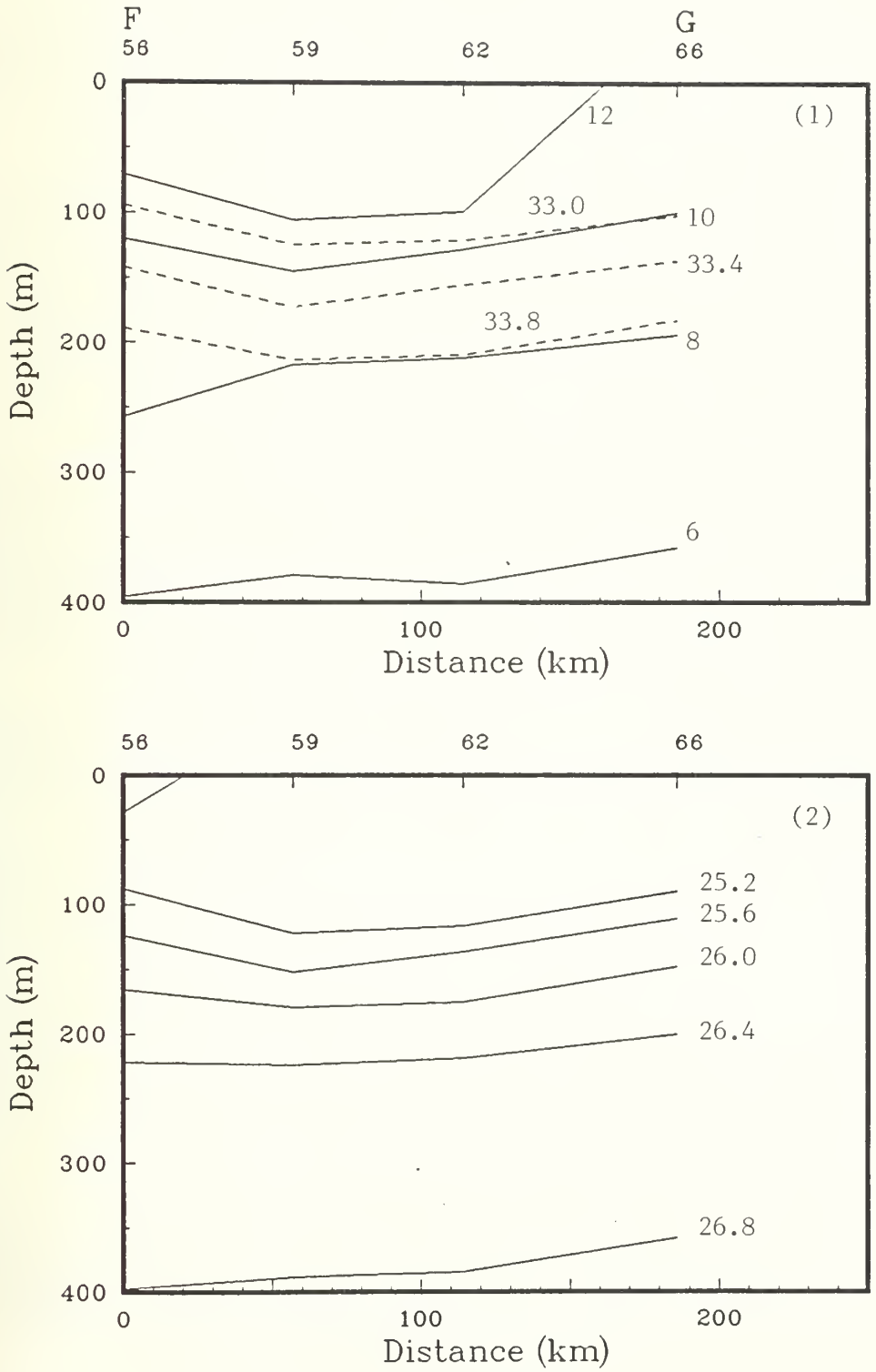

F
G
56
59
62
66
0
100
200
300
400
Depth (m)
12
(1)
33.0
10
33.4
33.8
8
6
0
100
200
Distance (km)
56
59
62
66
0
100
200
300
400
Depth (m)
(2)
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 8(f)

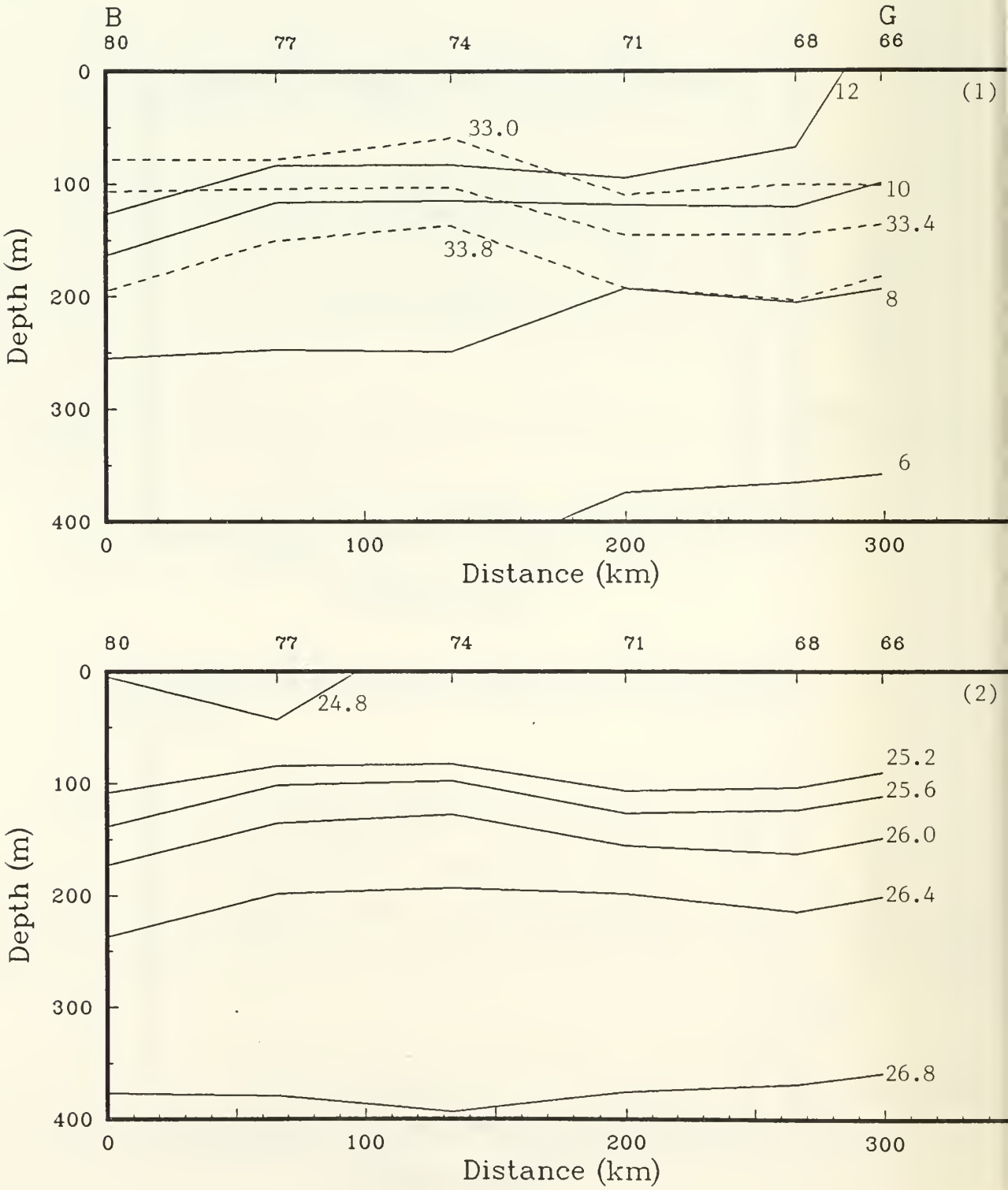

B
G
80
77
74
71
68
66
0
100
200
300
400
Depth (m)
(1)
12
33.0
10
33.4
33.8
8
6
0
100
200
300
Distance (km)
80
77
74
71
68
66
0
100
200
300
400
Depth (m)
(2)
24.8
25.2
25.6
26.0
26.4
26.8
0
100
200
300
Distance (km)

Figure 8(g)

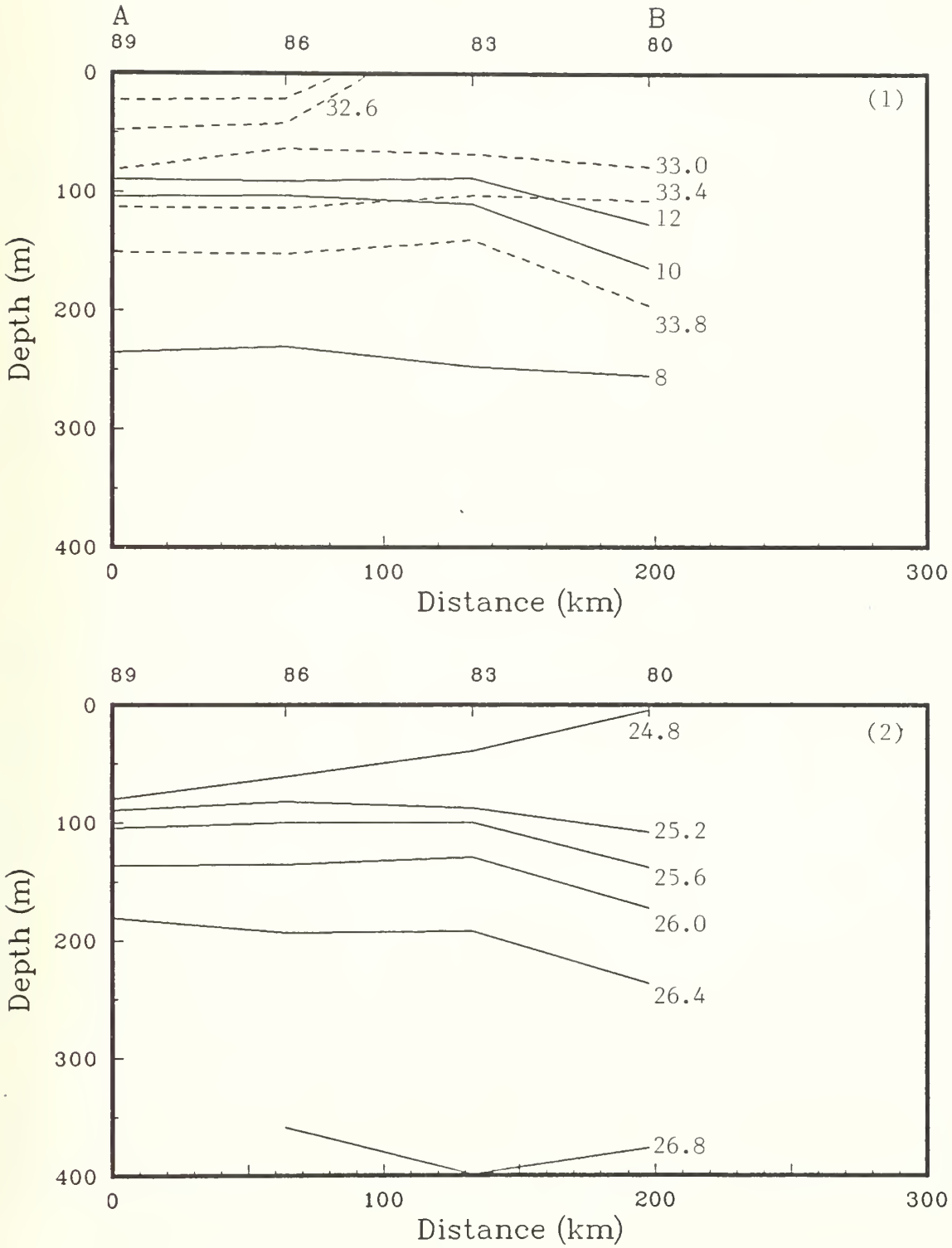

A
B
89
86
83
80
(1)
32.6
33.0
33.4
12
10
33.8
8
Depth (m)
0
100
200
300
400
0
100
200
300
Distance (km)
89
86
83
80
(2)
24.8
25.2
25.6
26.0
26.4
26.8
Depth (m)
0
100
200
300
400
0
100
200
300
Distance (km)

Figure 8(h)

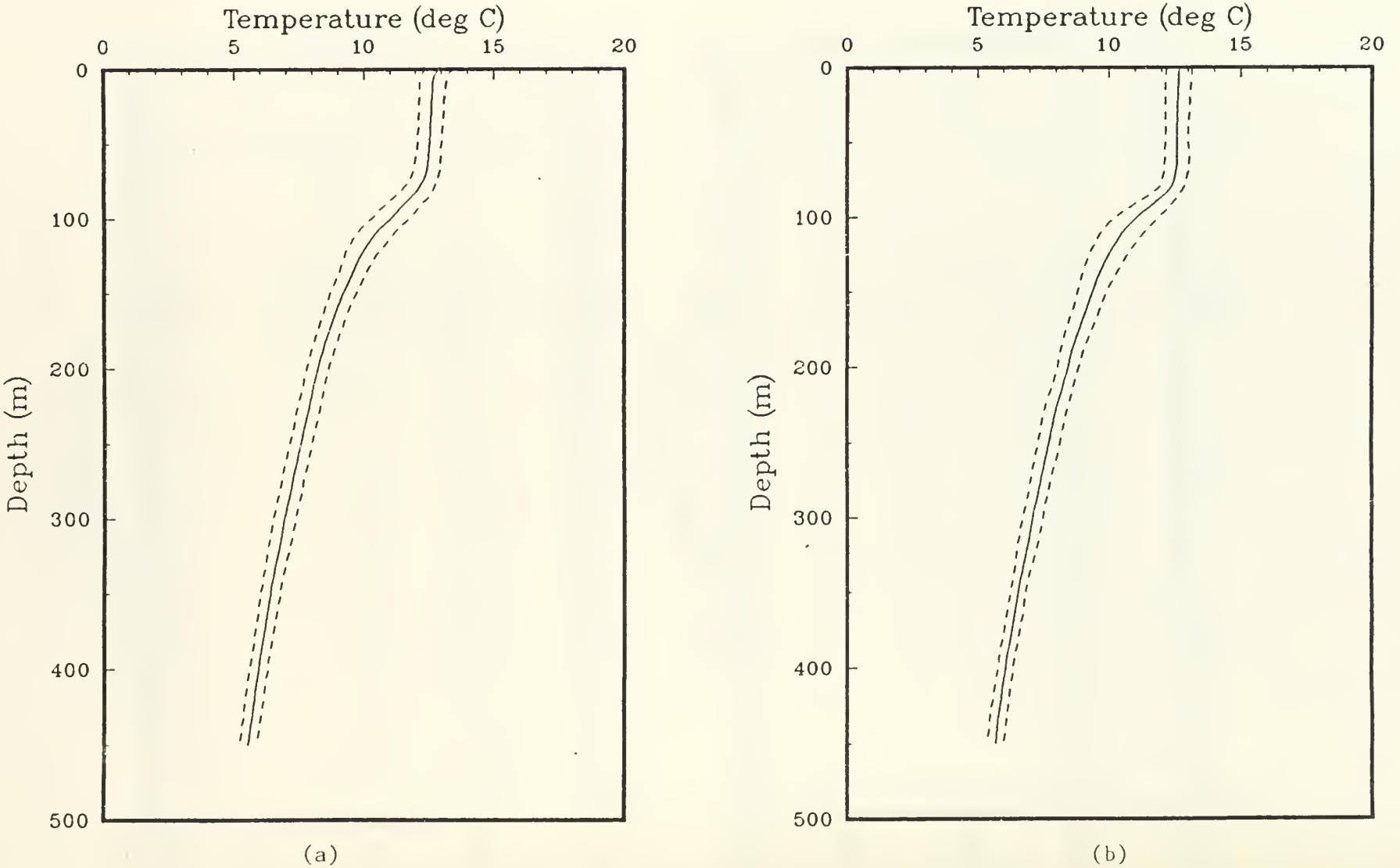


Figure 9 : Profiles of $\overline{T(z)}$ with + and - the standard deviation from (a) XBT's and (b) CTD's (OPTOMA4, Leg I).

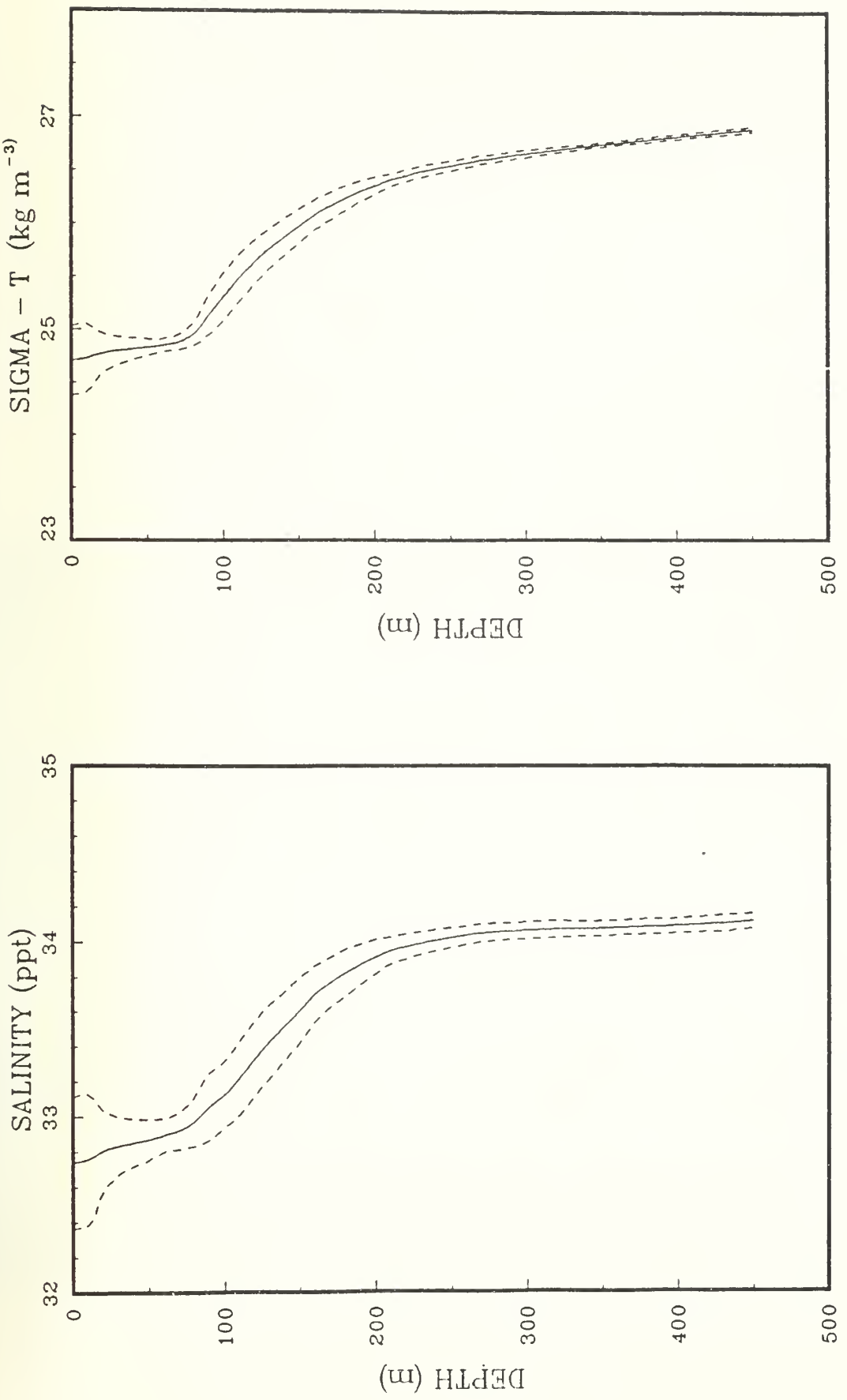


Figure 10: Profiles of (a) mean salintiy and (b) mean sigma-t, with + and - the standard deviations, from the CTD's (OPTOMA4, Leg I).

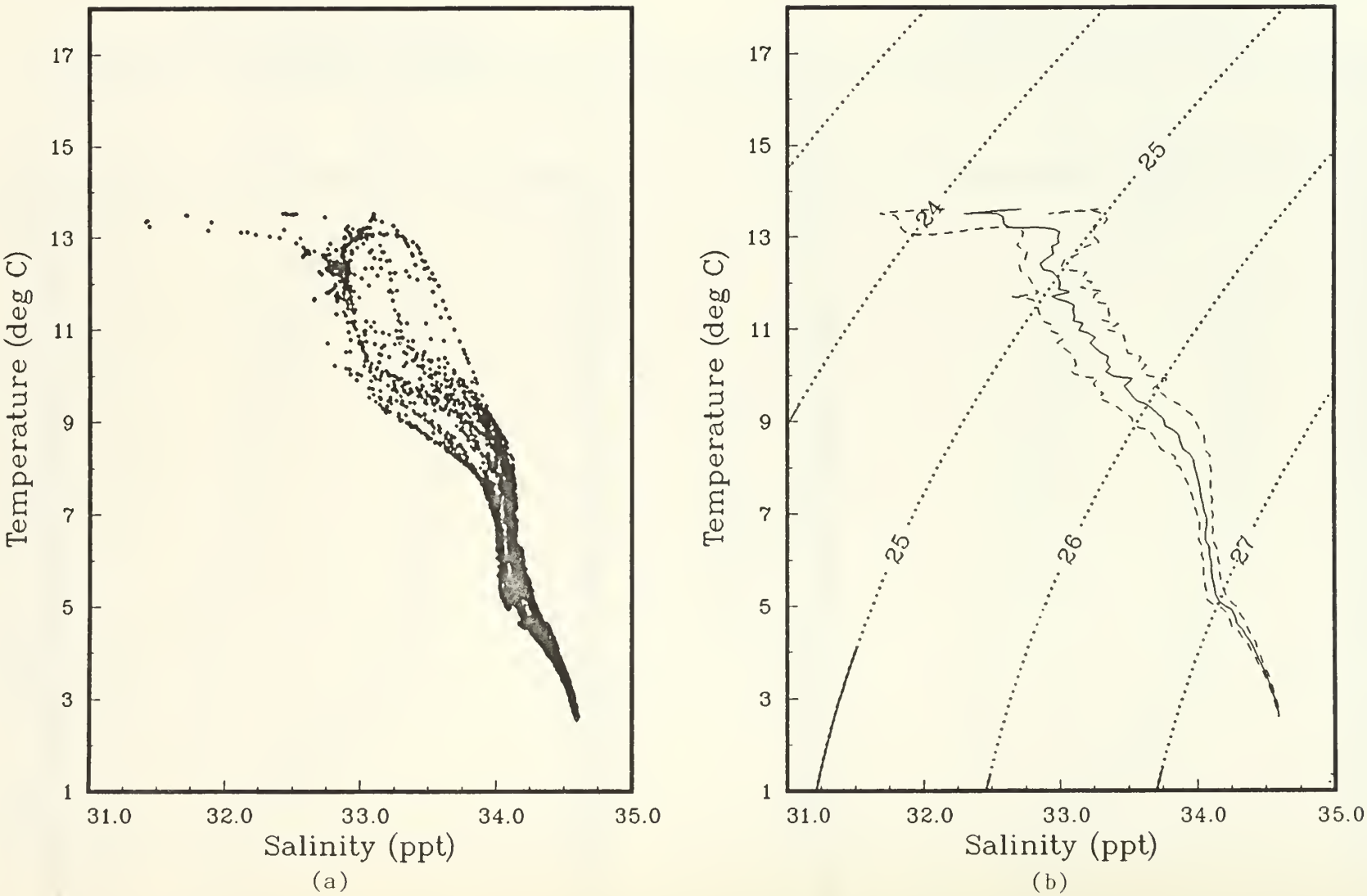


Figure 11: (a) T-S pairs and (b) mean T-S relationship, with + and - the standard deviation, and selected sigma-t contours, from the CTD casts (OPTOMA4, Leg I).

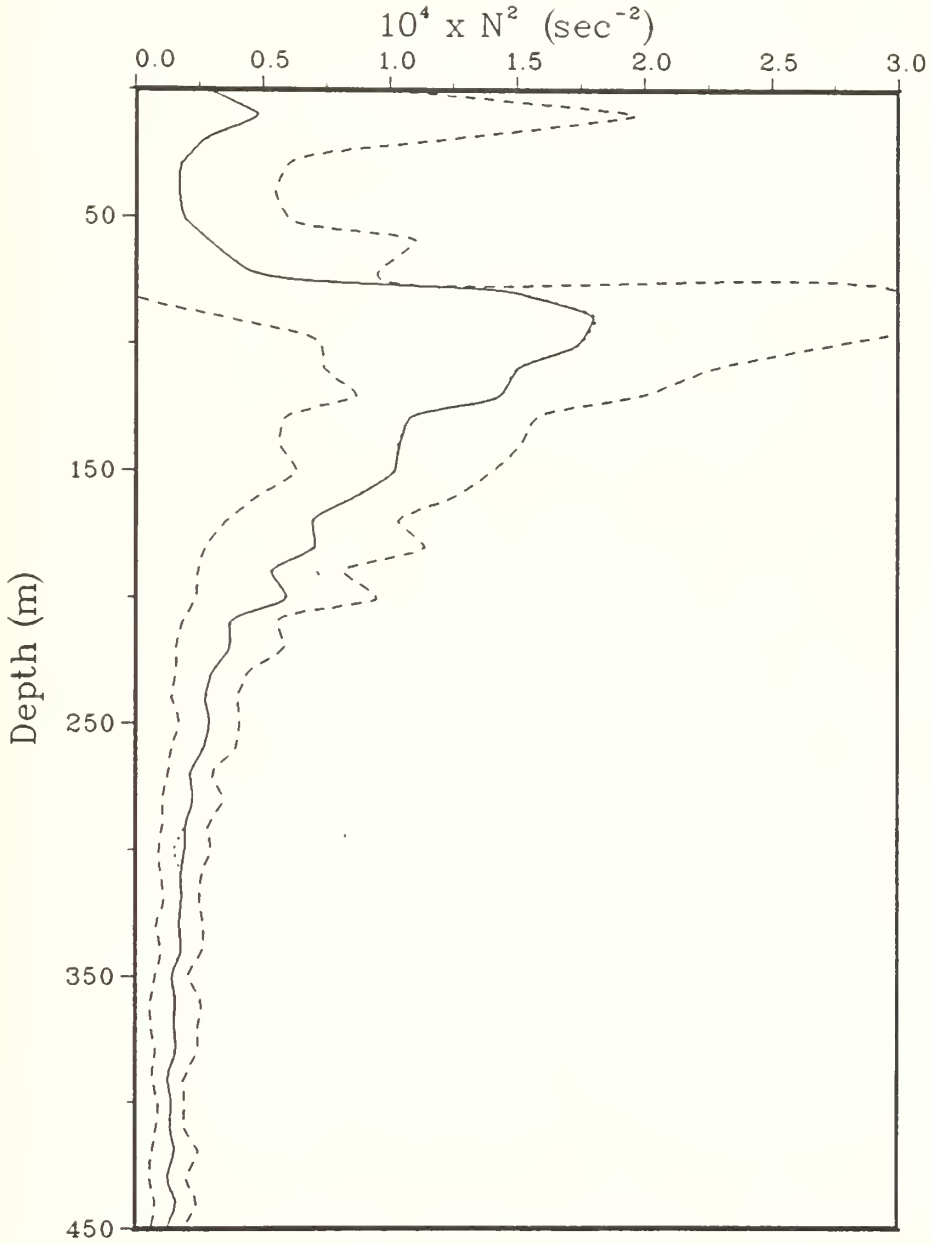


Figure 12: Profile of $\overline{N^2(z)}$ (_____), with + and - the standard deviation (---), and the profile of N^2 from $\overline{T(z)}$ and $\overline{S(z)}$ (...) (OPTOMA4, Leg I).

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SECTION 2

OPTOMA4 Leg II

5 - 10 April 1983

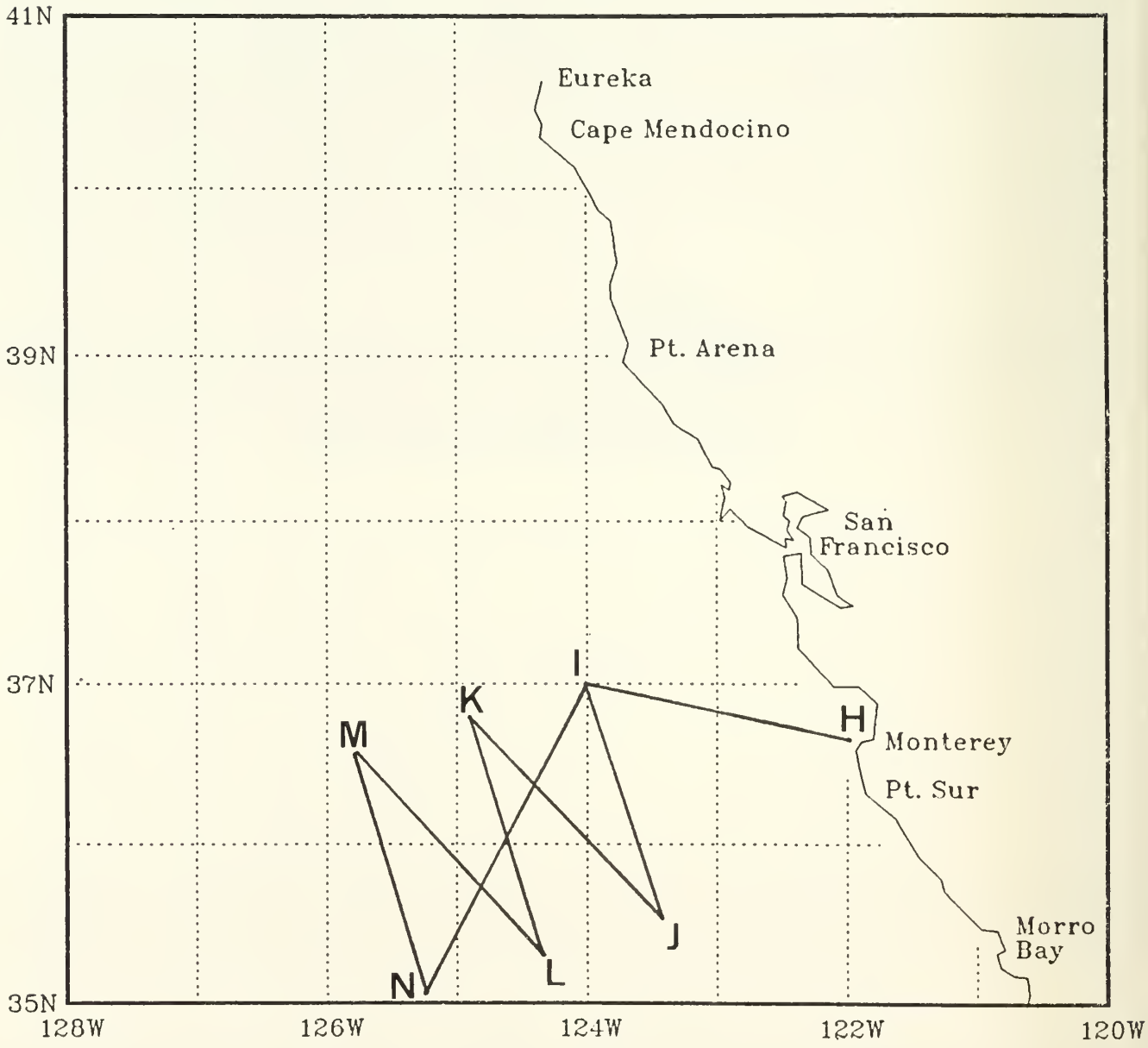


Figure 13: Cruise track for OPTOMA4, Leg II with transect extremes identified by letter.

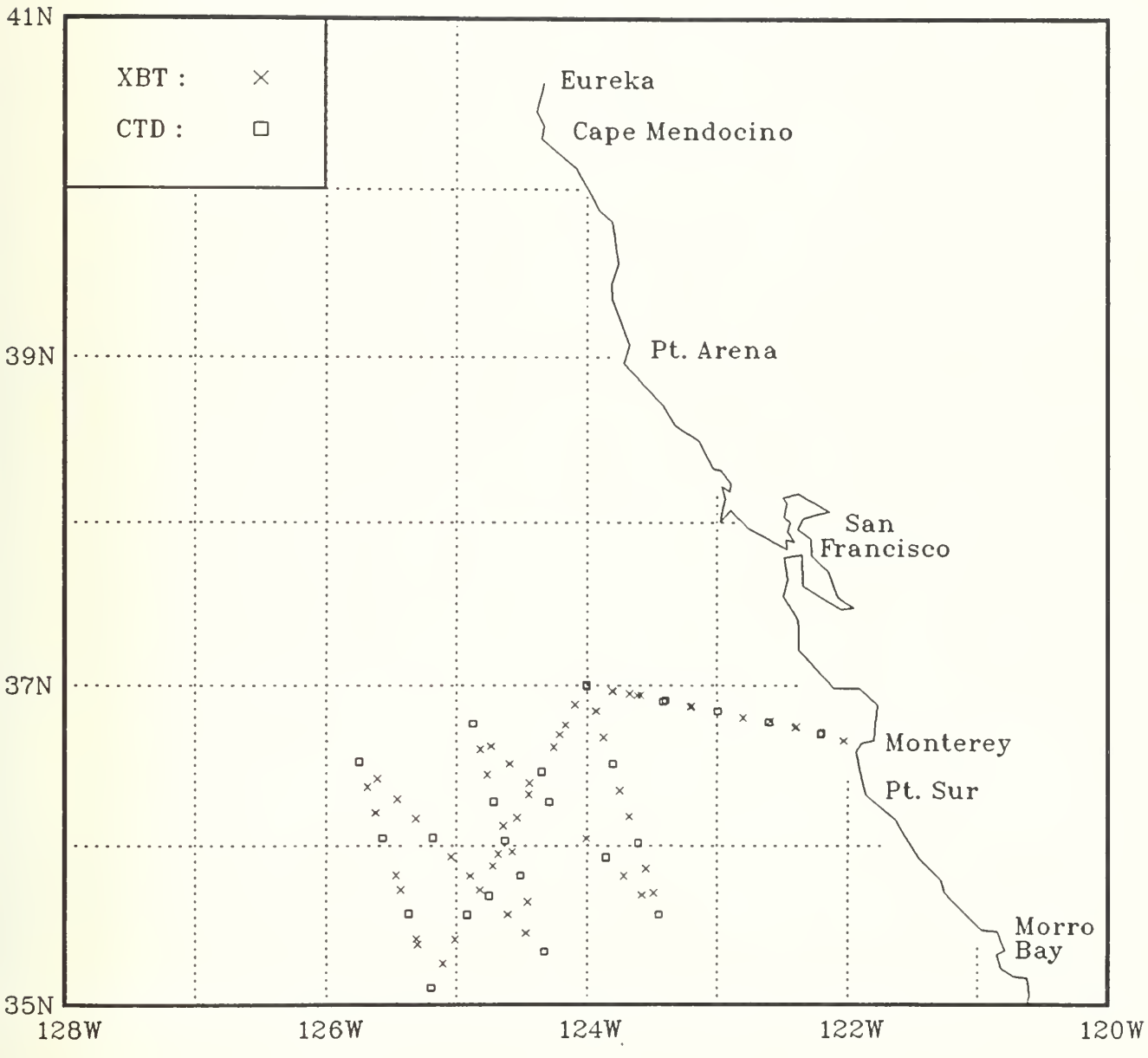


Figure 14: XBT and CTD locations for OPTOMA4, Leg II.

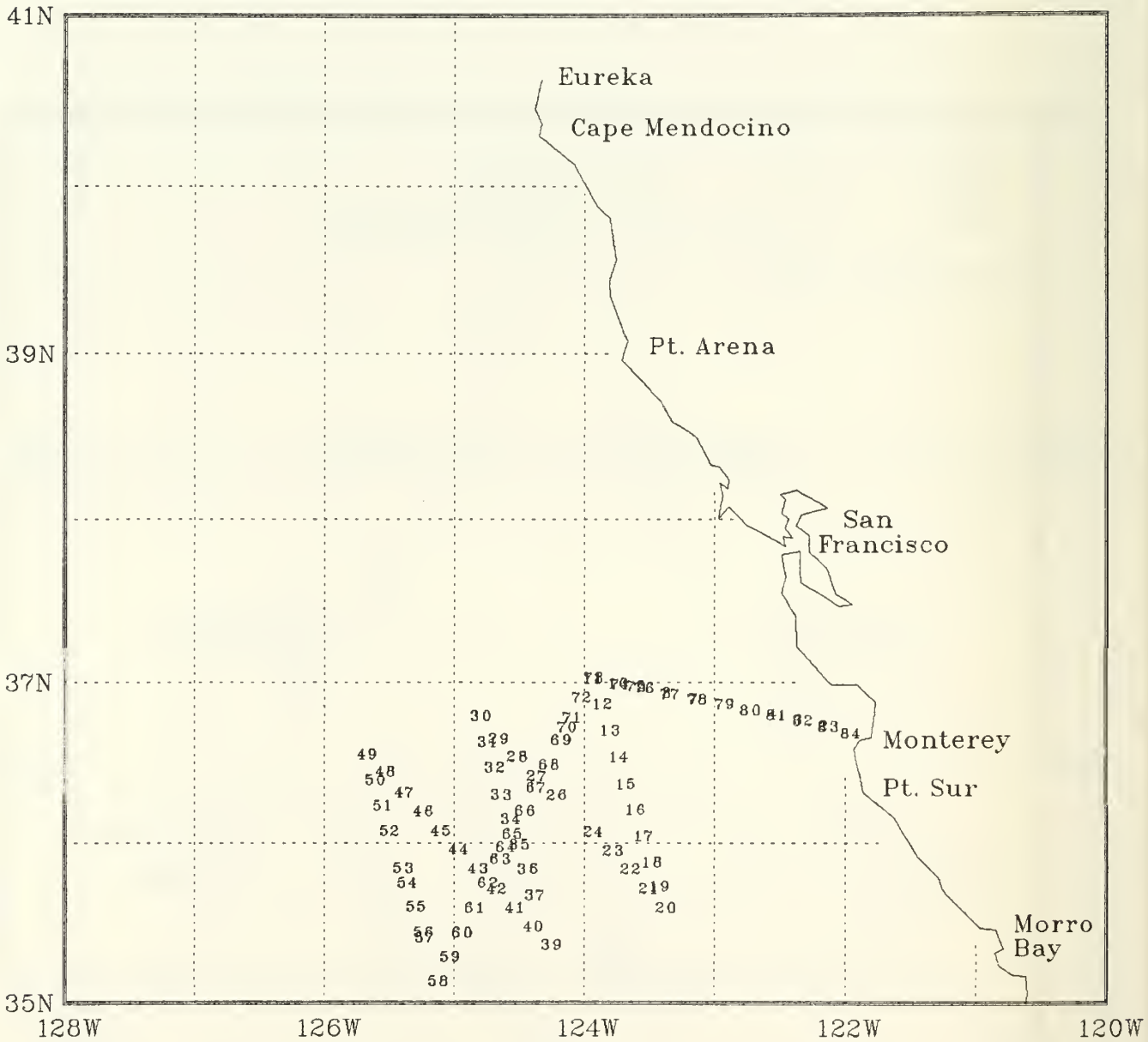


Figure 15: Station numbers for OPTOMA4, Leg II.

Table 3: Leg II Station Listing

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
2	CTD	83095	1716	36.42	122.12	12.8	32.87	12.8	32.94
3	XBT	83095	1900	36.45	122.23	12.9			
4	XBT	83095	2013	36.47	122.35	13.1			
7	XBT	83095	2357	36.52	123.12	13.8			
8	CTD	83096	107	36.54	123.24	13.4	31.31	13.0	31.32
9	XBT	83096	234	36.56	123.35	13.3			
10	XBT	83096	345	36.58	123.48	13.3			
11	CTD	83096	457	37.00	124.00	13.0	32.58	12.9	32.59
12	XBT	83096	703	36.50	123.56	12.9			
13	XBT	83096	808	36.41	123.52	13.1			
14	CTD	83096	917	36.31	123.48	13.4	33.02	13.2	32.94
15	XBT	83096	1044	36.21	123.45	13.6			
16	XBT	83096	1146	36.11	123.40	13.8			
17	CTD	83096	1254	36.01	123.36	13.6	32.65	13.2	32.64
18	XBT	83096	1419	35.51	123.33	13.9			
19	XBT	83096	1520	35.42	123.29	13.9			
20	CTD	83096	1620	35.34	123.27	13.7	32.28	13.8	32.26
21	XBT	83096	1845	35.41	123.35	14.2			
22	XBT	83096	2001	35.49	123.43	13.8			
23	CTD	83096	2113	35.56	123.51	13.9	33.10	13.9	33.13
24	XBT	83096	2253	36.03	124.00	14.2			
26	CTD	83097	123	36.17	124.17	14.1	33.24	14.0	33.21
27	XBT	83097	314	36.24	124.26	14.3			
28	XBT	83097	435	36.31	124.35	14.3			
29	XBT	83097	551	36.37	124.44	14.7			
30	CTD	83097	746	36.46	124.52	14.0	33.25	13.8	33.28
31	XBT	83097	953	36.36	124.49	14.2			
32	XBT	83097	1057	36.27	124.46	14.7			
33	CTD	83097	1210	36.16	124.43	14.3	33.45	14.3	33.44
34	XBT	83097	1339	36.08	124.38	14.7			
35	XBT	83097	1445	35.58	124.34	14.4			
36	CTD	83097	1548	35.49	124.31	14.1	33.28	14.1	33.27
37	XBT	83097	1719	35.39	124.27	14.0			
39	CTD	83097	1933	35.20	124.20	14.1	33.19	14.0	33.18
40	XBT	83097	2204	35.27	124.28	13.6			
41	XBT	83097	2323	35.34	124.36	14.2			
42	CTD	83098	107	35.41	124.45	14.2	33.35	14.0	33.39
43	XBT	83098	343	35.49	124.54	14.2			
44	XBT	83098	531	35.56	125.03	14.1			
45	CTD	83098	808	36.03	125.11	14.2	33.27	13.9	33.29
46	XBT	83098	1115	36.10	125.19	14.1			
47	XBT	83098	1354	36.18	125.27	14.1			
48	XBT	83098	1556	36.25	125.36	14.1			
49	CTD	83098	1739	36.32	125.45	14.0	33.24	13.9	33.23
50	XBT	83098	1947	36.22	125.41	13.3			

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
51	XBT	83098	2054	36.13	125.37	14.2			
52	CTD	83098	2205	36.03	125.34	14.2	33.20	14.3	33.23
53	XBT	83099	10	35.49	125.28	14.6			
54	XBT	83099	49	35.44	125.26	14.2			
55	CTD	83099	156	35.35	125.22	14.3	33.29	14.2	33.28
56	XBT	83099	326	35.25	125.18	14.4			
57	XBT	83099	345	35.23	125.18	14.3			
58	CTD	83099	543	35.06	125.12	14.1	33.22	14.8	33.21
59	XBT	83099	809	35.16	125.06	14.0			
60	XBT	83099	923	35.25	125.01	14.1			
61	CTD	83099	1038	35.34	124.55	13.8	33.19	13.8	33.18
62	XBT	83099	1218	35.44	124.49	13.8			
63	XBT	83099	1332	35.53	124.43	14.1			
64	XBT	83099	1409	35.57	124.41	14.4			
65	CTD	83099	1451	36.02	124.38	14.3	33.49	14.1	33.49
66	XBT	83099	1717	36.11	124.32	14.2			
67	XBT	83099	1827	36.19	124.27	14.3			
68	CTD	83099	1936	36.28	124.21	14.3	33.45	14.3	33.45
69	XBT	83099	2124	36.37	124.15	14.1			
70	XBT	83099	2205	36.42	124.12	13.6			
71	XBT	83099	2237	36.45	124.10	12.9			
72	XBT	83099	2338	36.53	124.05	13.0			
73	CTD	83100	46	37.00	124.00	12.9	32.43	12.9	32.55
74	XBT	83100	258	36.58	123.48	12.7			
75	XBT	83100	341	36.57	123.40	12.9			
76	XBT	83100	404	36.56	123.37	13.2			
77	CTD	83100	515	36.54	123.25	13.3	31.54	12.6	31.76
78	XBT	83100	645	36.52	123.12	13.3			
79	CTD	83100	754	36.50	123.00	13.0	31.76	12.9	31.77
80	XBT	83100	919	36.48	122.48	13.2			
81	CTD	83100	1024	36.46	122.36	13.0	31.77	12.6	32.24
82	XBT	83100	1146	36.44	122.24	13.2			
83	CTD	83100	1247	36.42	122.12	12.7	32.23	*	*
84	XBT	83100	1407	36.39	122.02	12.3			

* Data not available

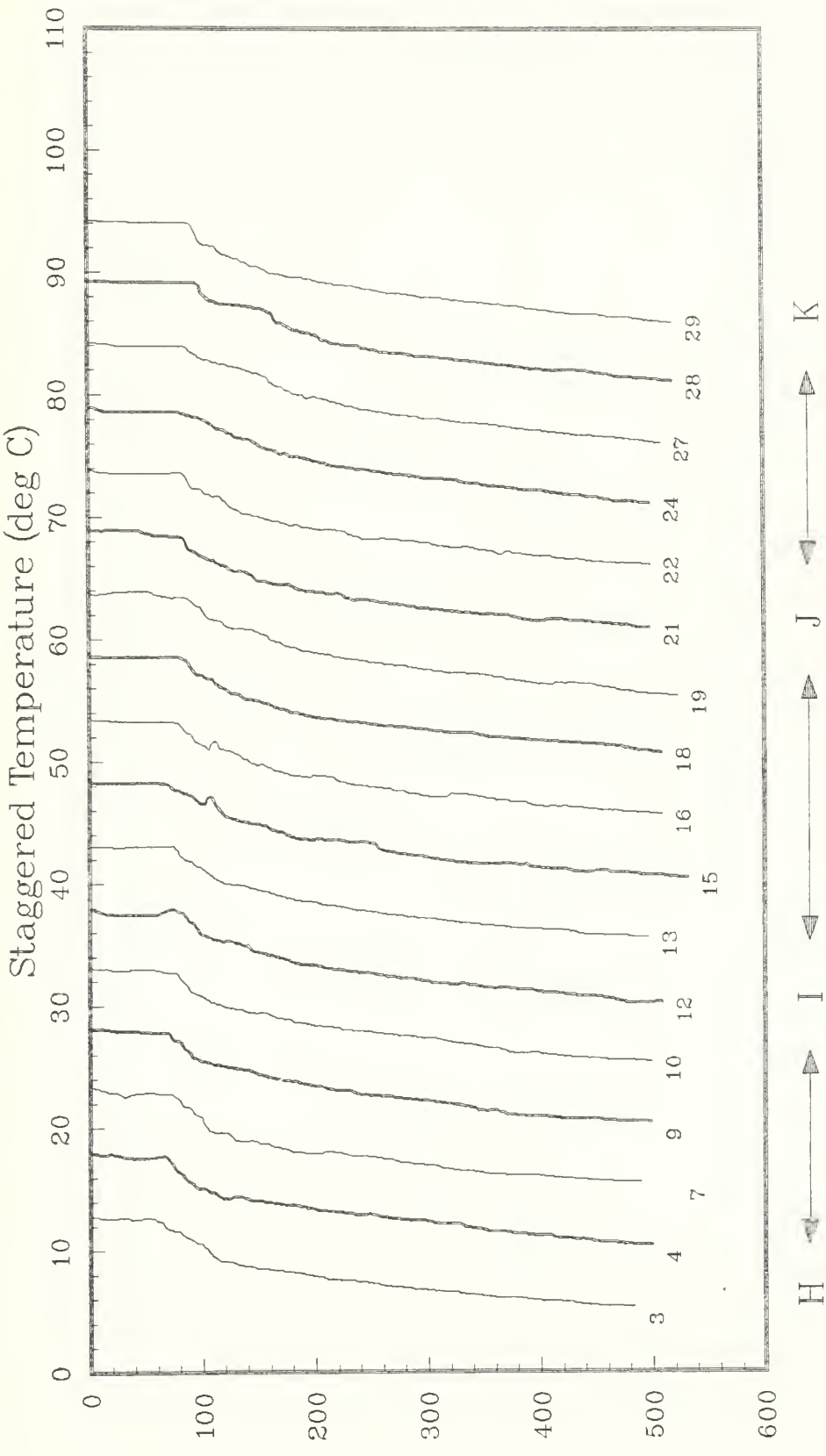


Figure 16(a): Staggered temperature profiles from the XBT's. Profiles are staggered by a multiple of 5C (OPTOMA4, Leg II).

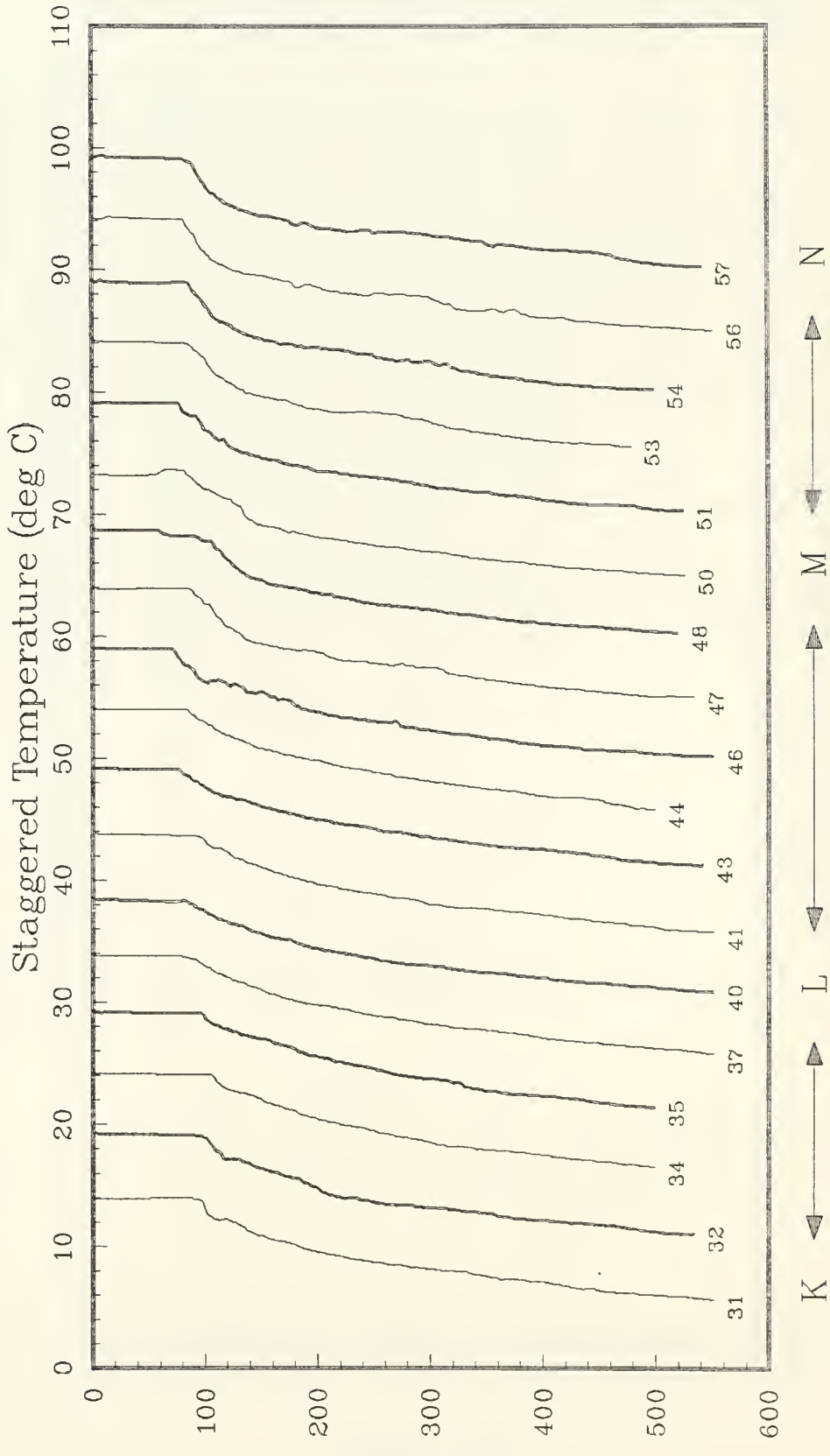

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
Depth (m)
0
100
200
300
400
500
600
31
32
34
35
37
40
41
43
44
46
47
48
50
51
53
54
56
57
K
L
M
N

Figure 16(b)

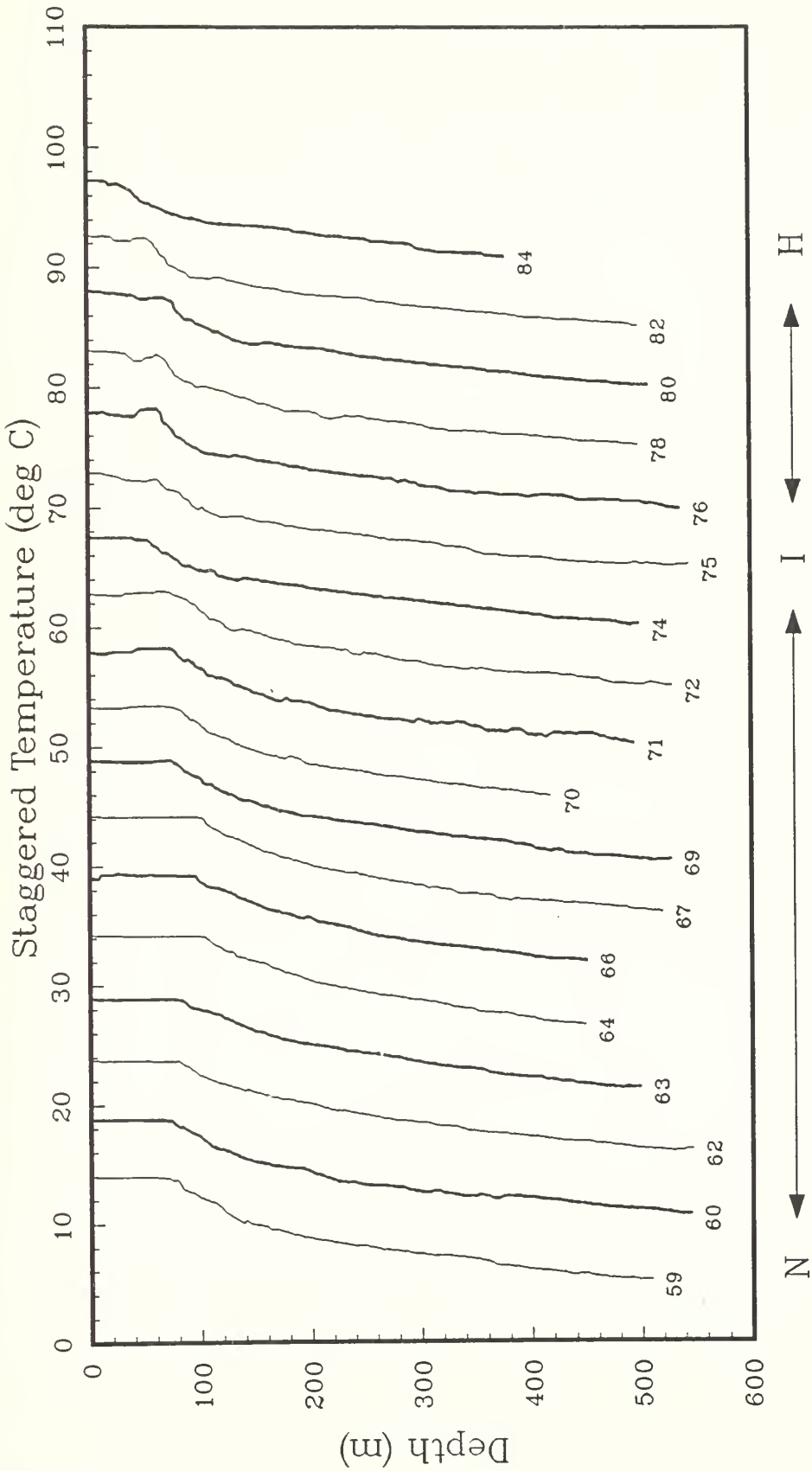

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
Depth (m)
0
100
200
300
400
500
600
59
60
62
63
64
66
67
69
70
71
72
74
75
76
78
80
82
84
N
I
H

Figure 16(c)

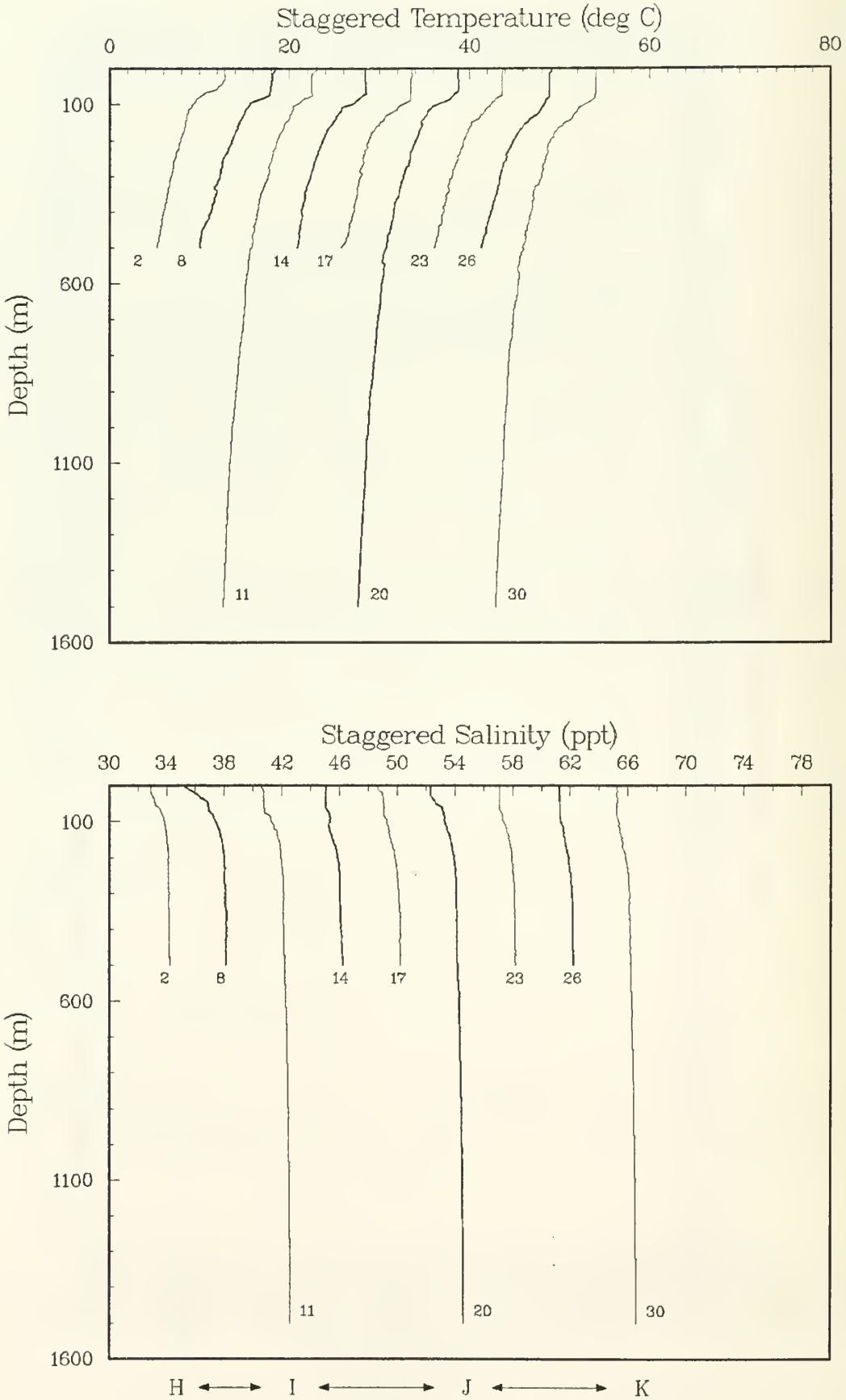
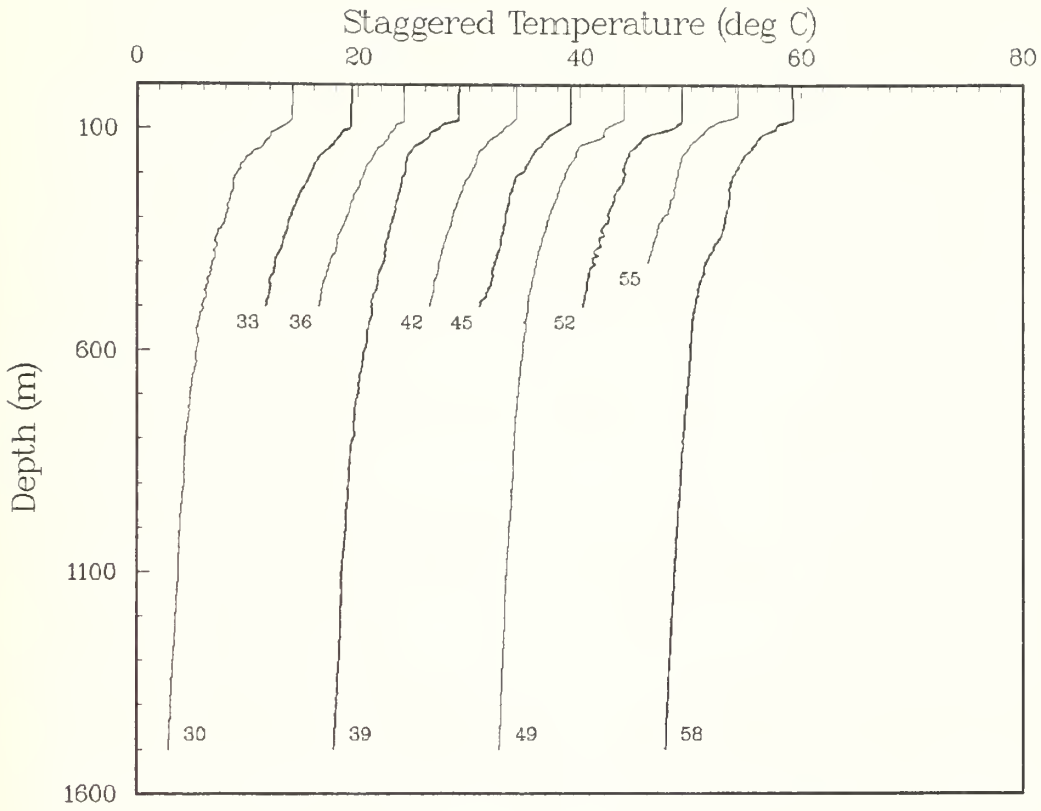


Figure 17(a): CTD temperature profiles, staggered by multiples of 5C, and salinity profiles staggered by multiples of 4 ppt (OPTOMA4, Leg II).


Staggered Temperature (deg C)
0
20
40
60
80
100
600
1100
1600
Depth (m)
33
36
42
45
52
55
30
39
49
58

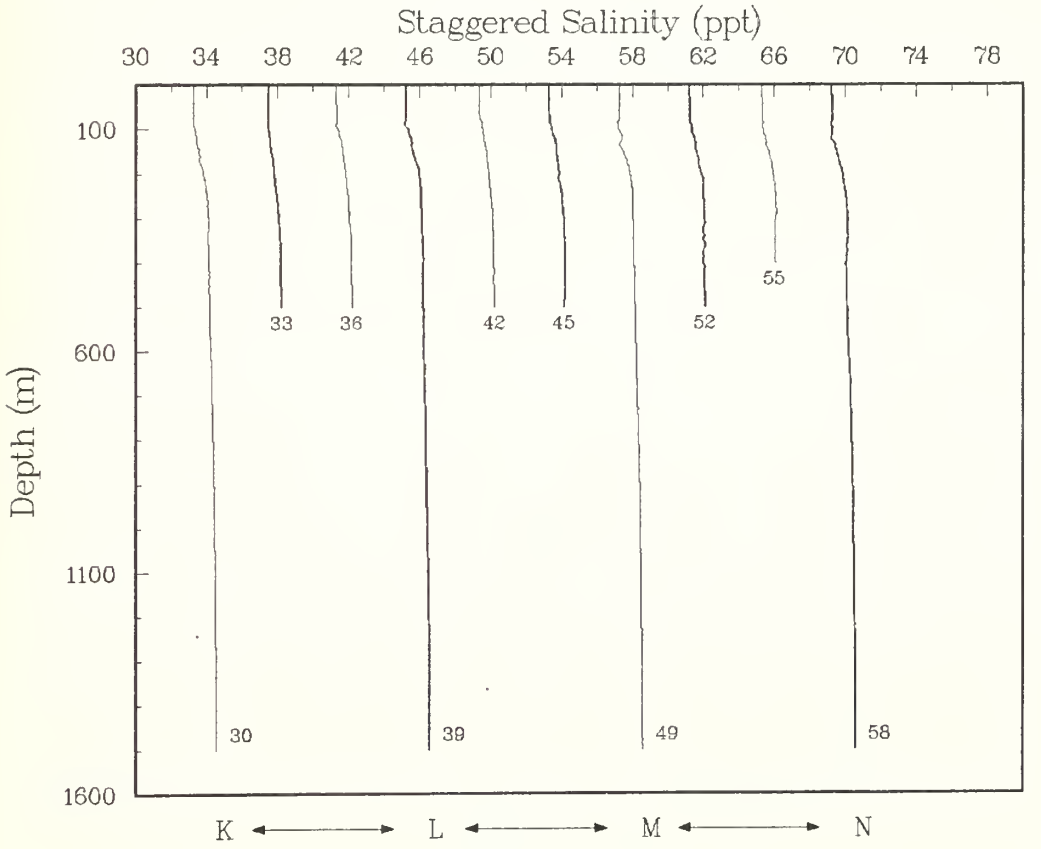
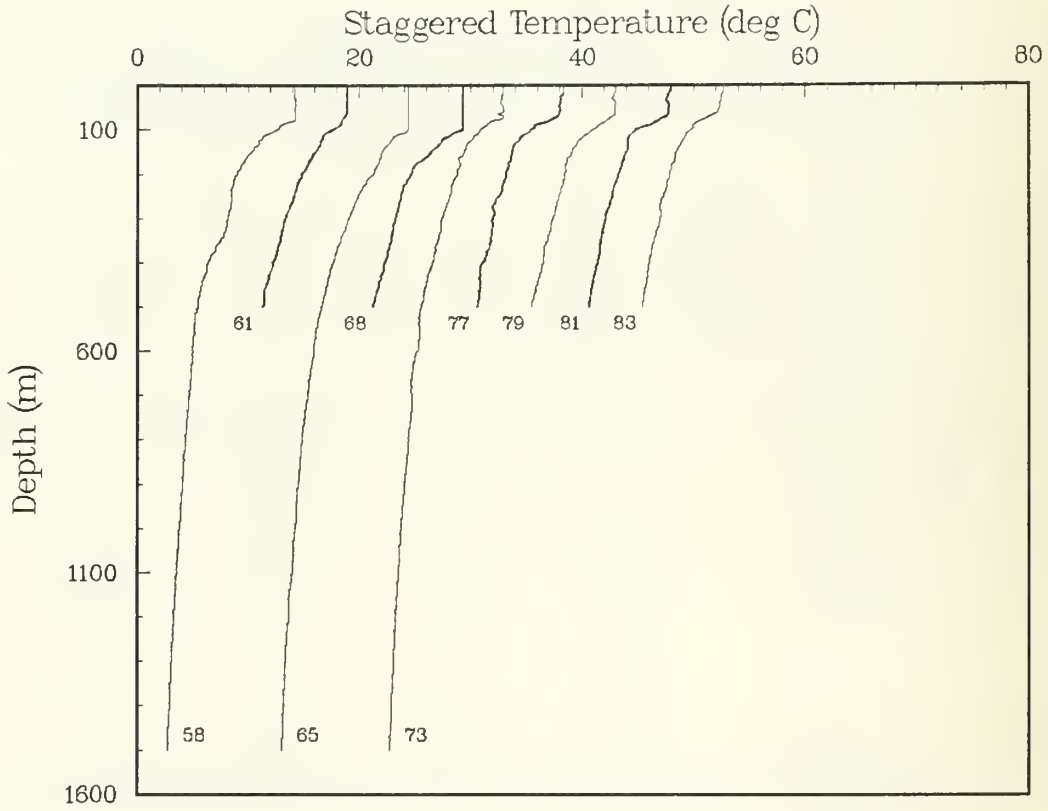

Staggered Salinity (ppt)
30
34
38
42
46
50
54
58
62
66
70
74
78
100
600
1100
1600
Depth (m)
33
36
42
45
52
55
30
39
49
58
K
L
M
N

Figure 17(b)


Staggered Temperature (deg C)
0
20
40
60
80
100
600
1100
1600
Depth (m)
61
68
77
79
81
83
58
65
73

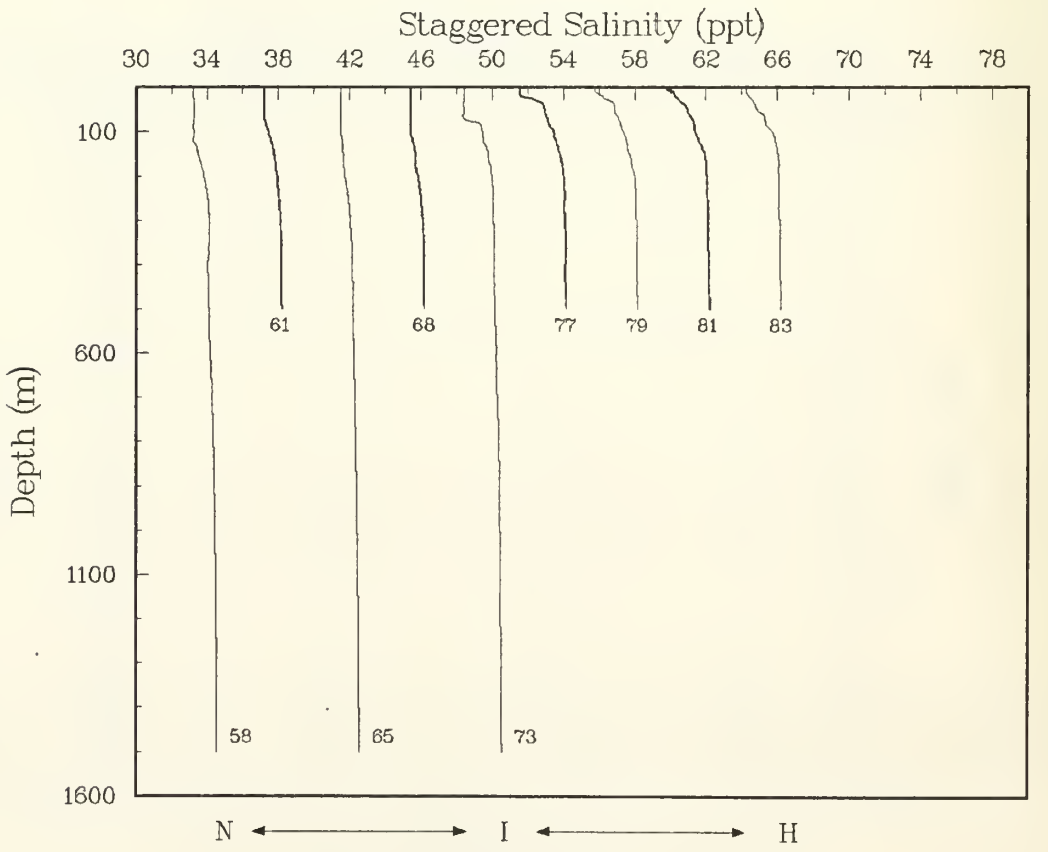
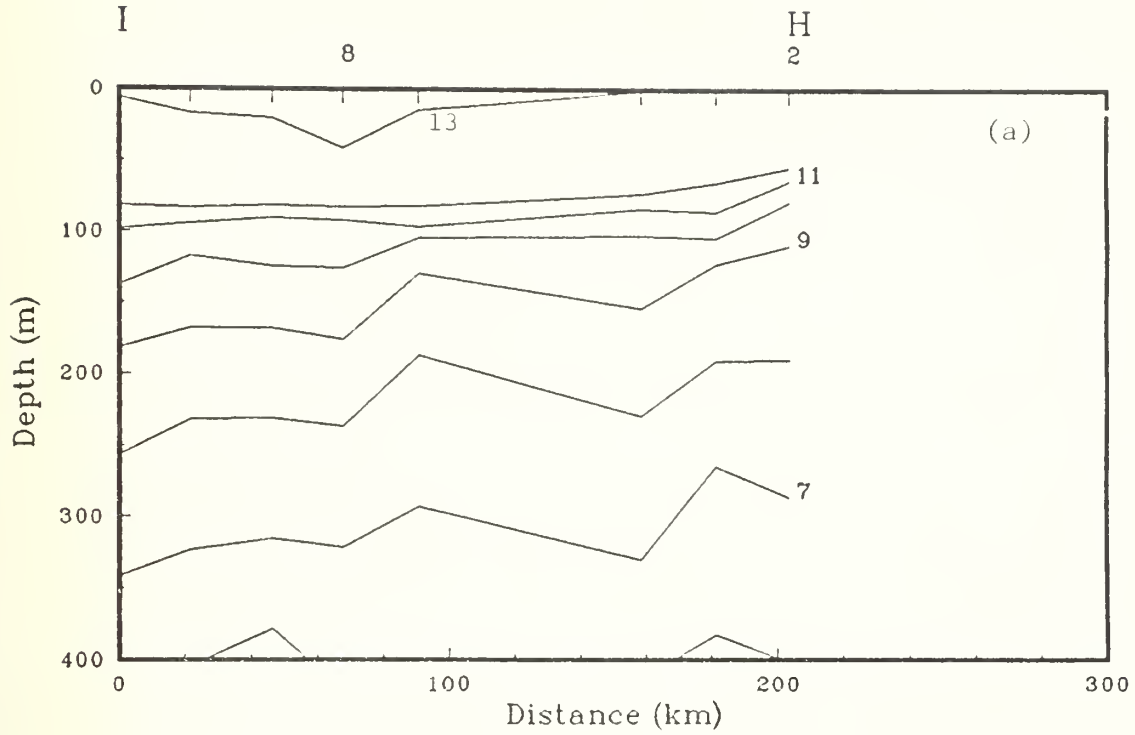

Staggered Salinity (ppt)
30
34
38
42
46
50
54
58
62
66
70
74
78
100
600
1100
1600
Depth (m)
61
68
77
79
81
83
58
65
73
N
I
H

Figure 17(c)



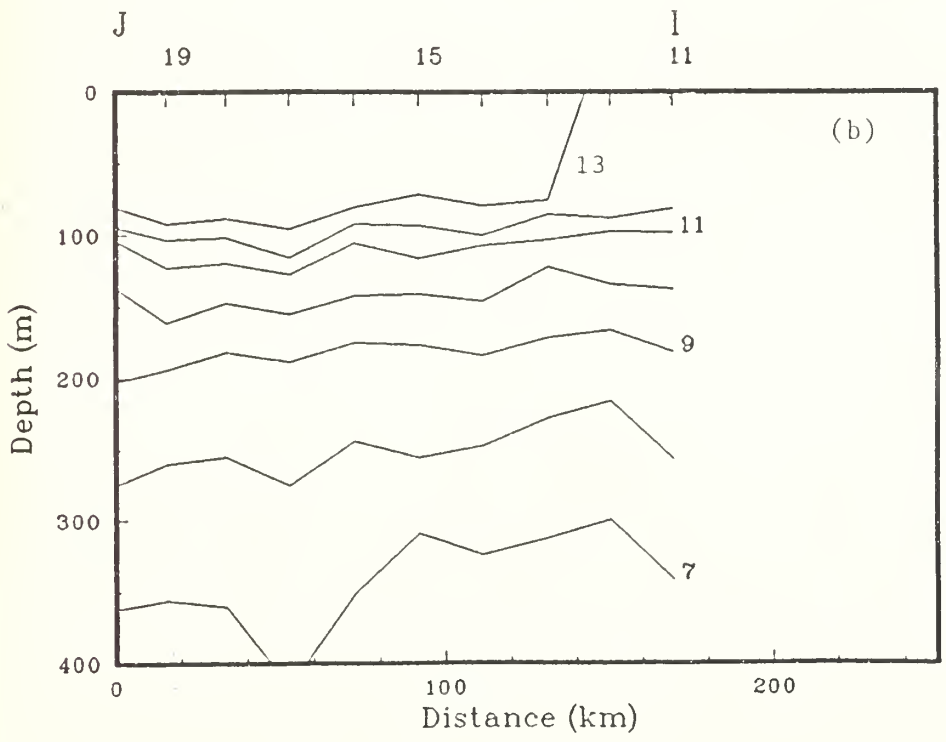


Figure 18(a), (b): Isotherms from XBT's and CTD's. Tick marks along the upper horizontal axis show station positions. Some station numbers are given (GPTOMA4, Leg II).

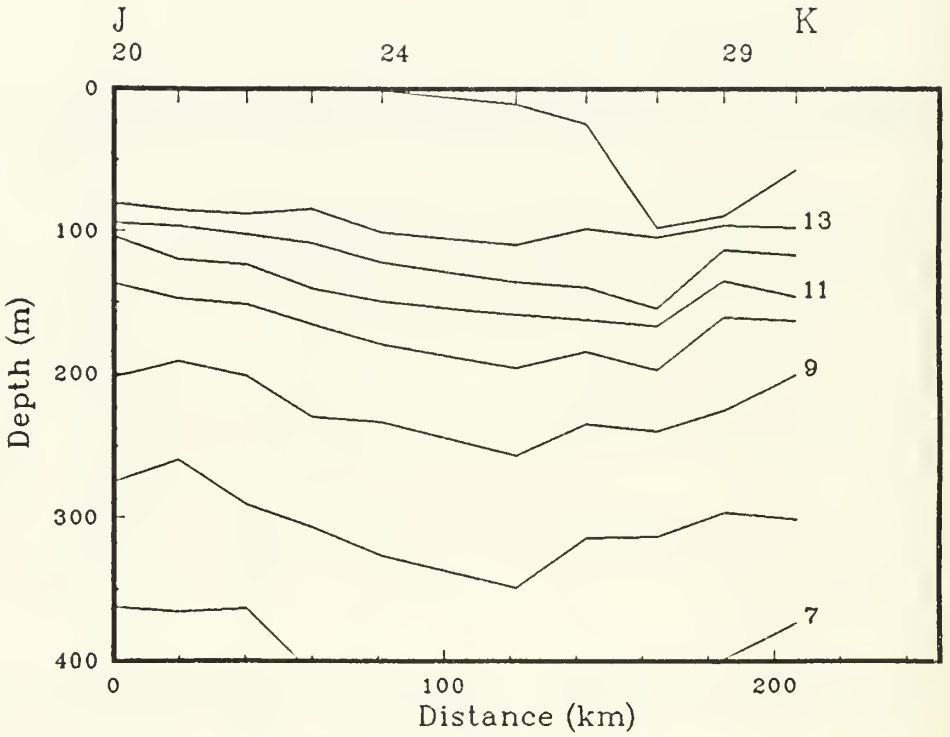


Figure 18(c)

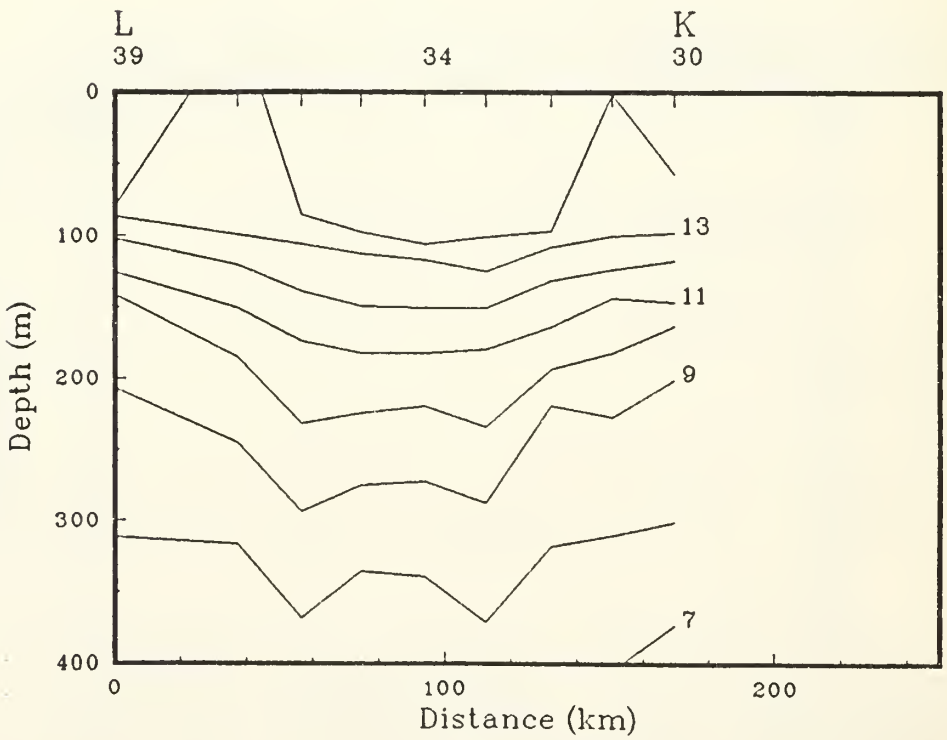


Figure 18(d)

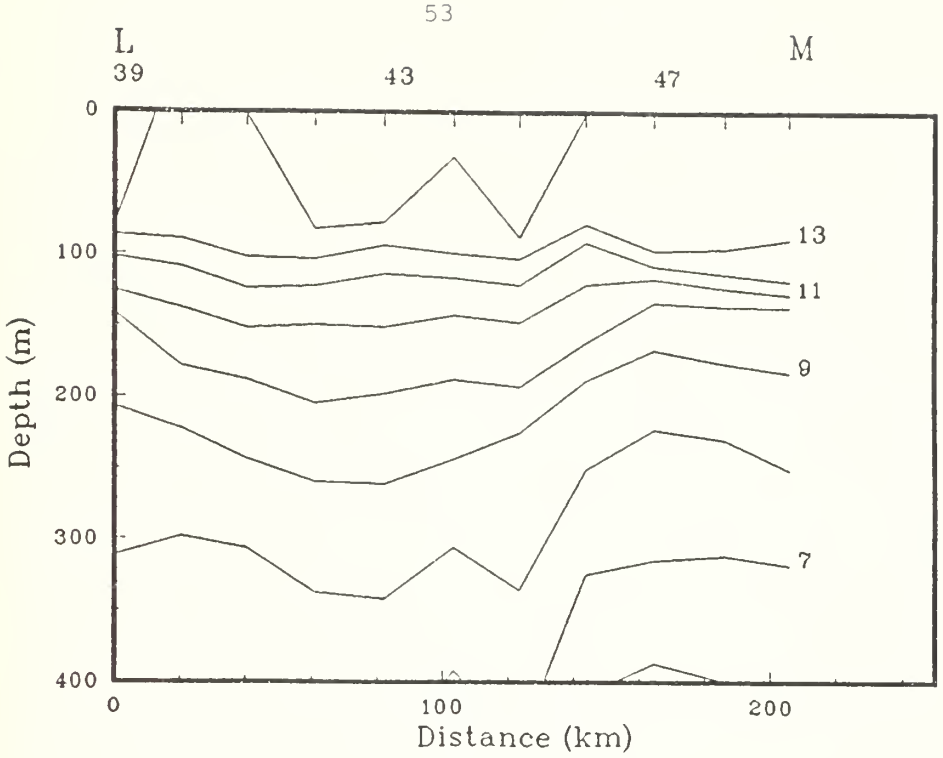


Figure 18(e)

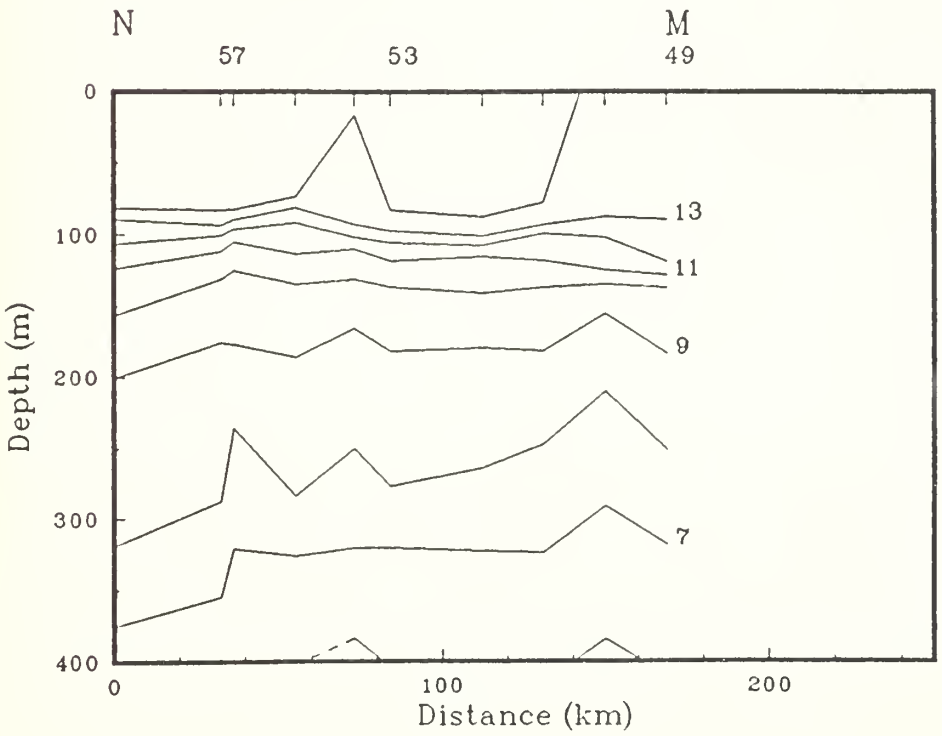


Figure 18(f)

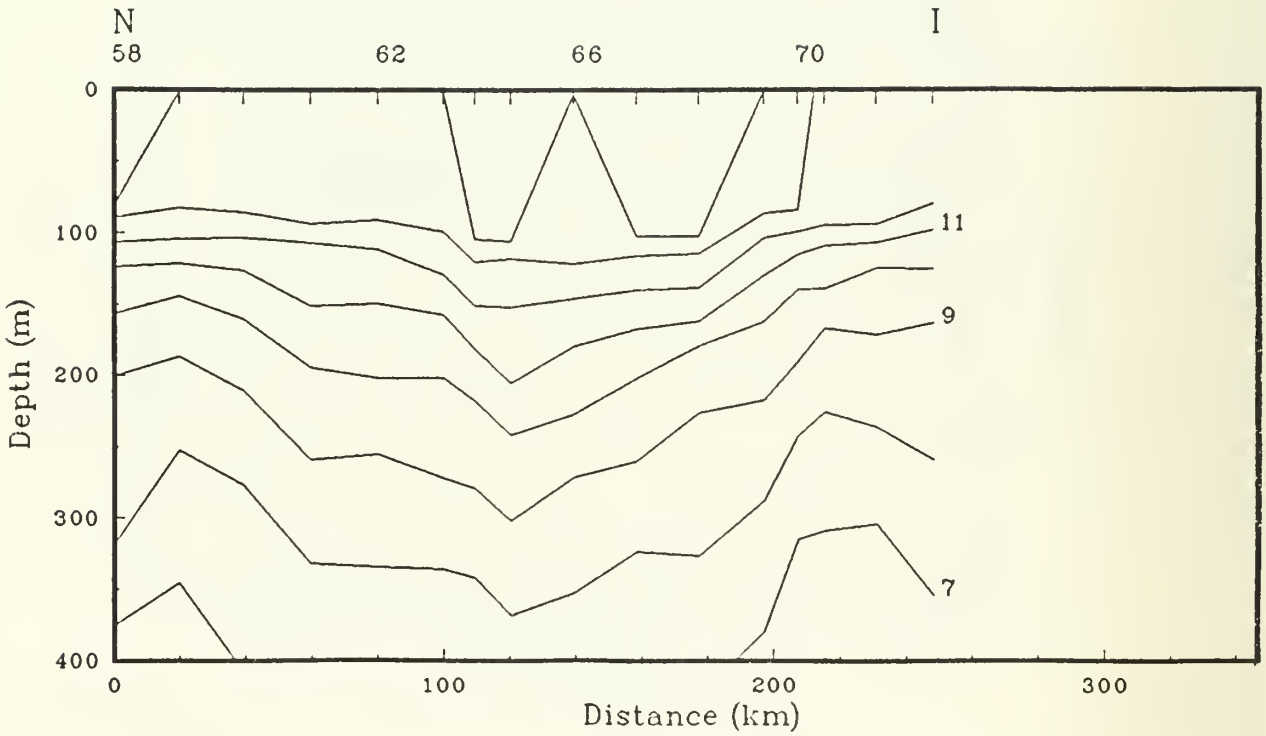


Figure 18(g)

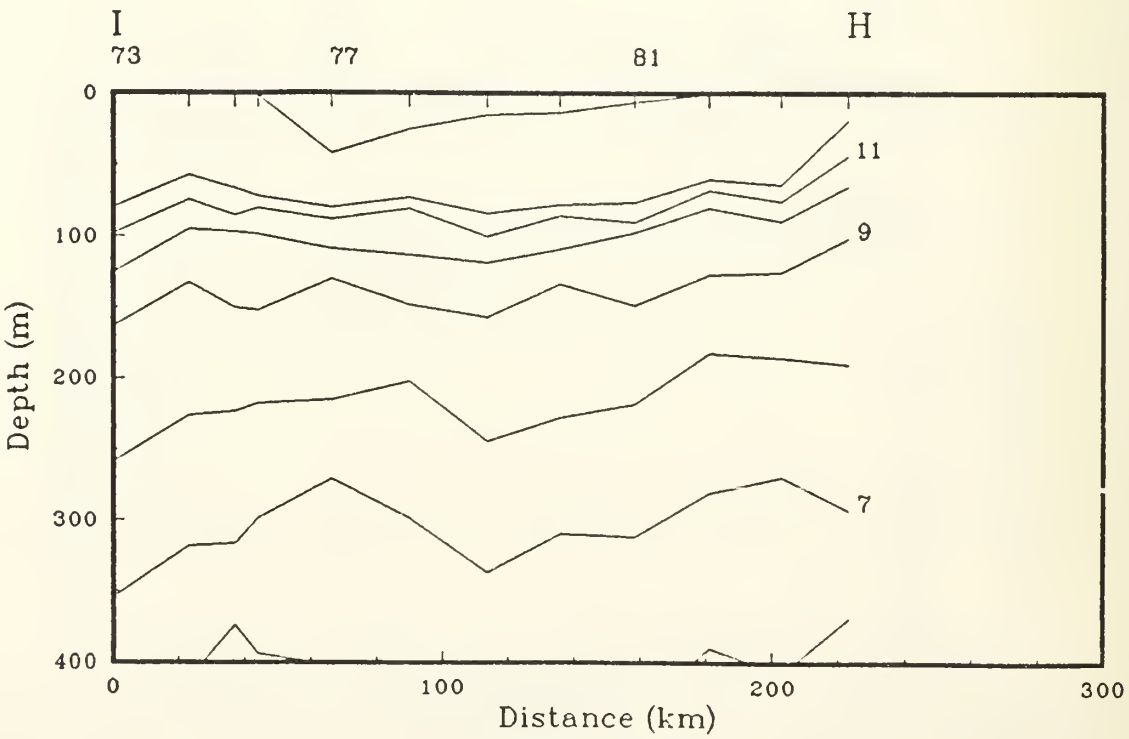


Figure 18(h)

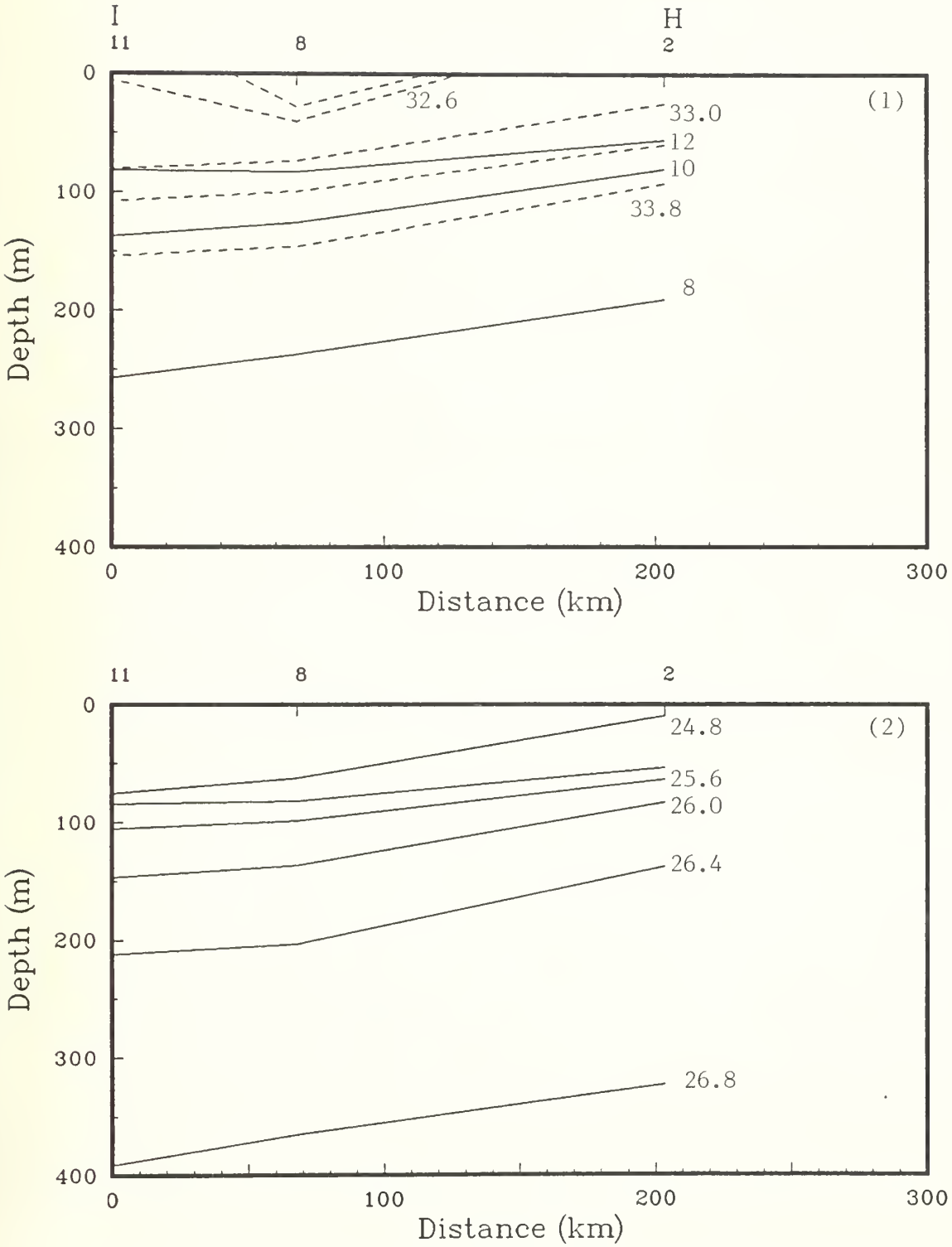


Figure 19(a): Isopleths of (1) temperature and salinity and (2) sigma-t from the CTD's (OPTOMA4, Leg II).

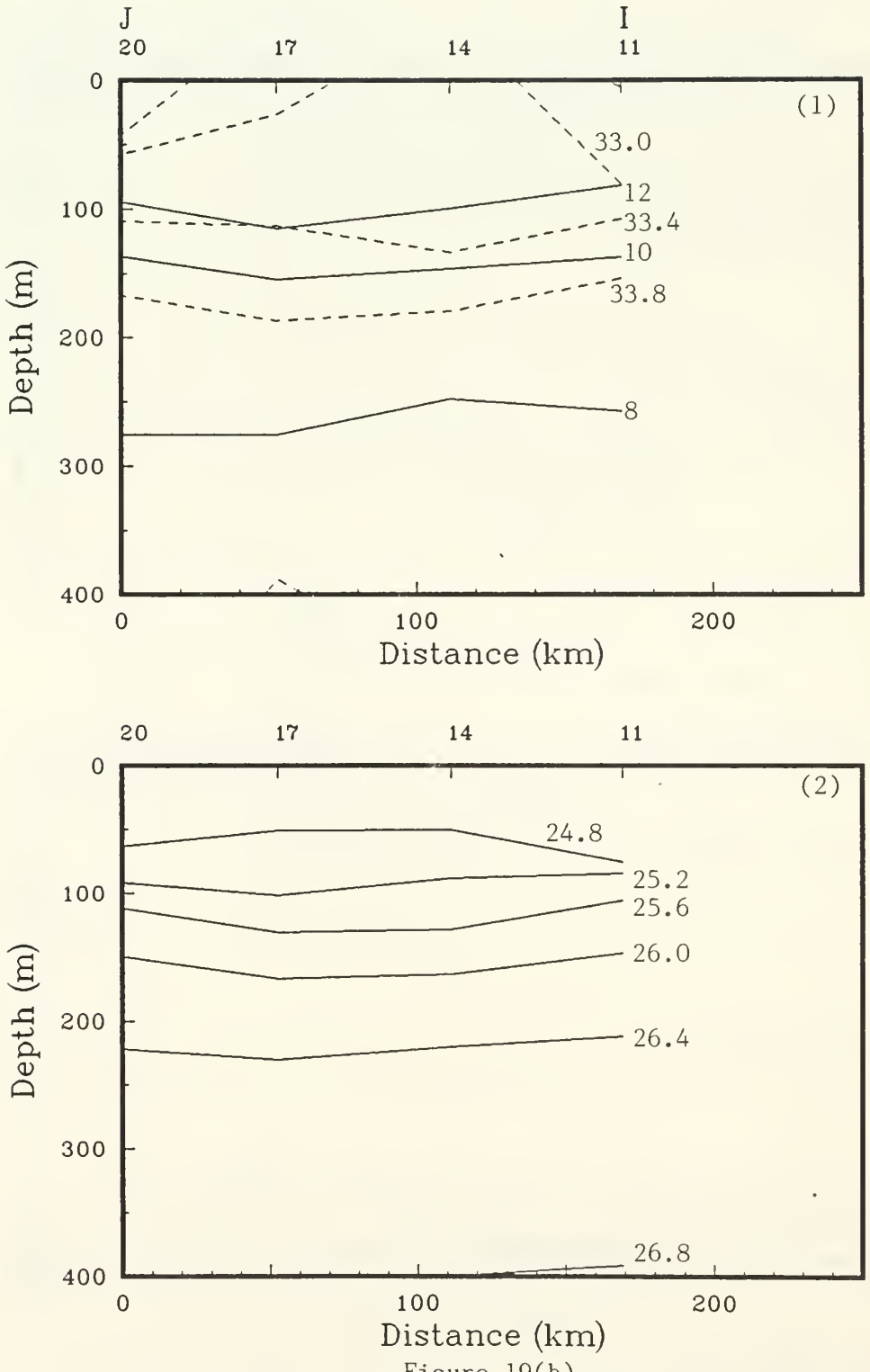

J
I
20
17
14
11
0
100
200
300
400
Depth (m)
(1)
33.0
12
33.4
10
33.8
8
0
100
200
Distance (km)
20
17
14
11
0
100
200
300
400
Depth (m)
(2)
24.8
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 19(b)

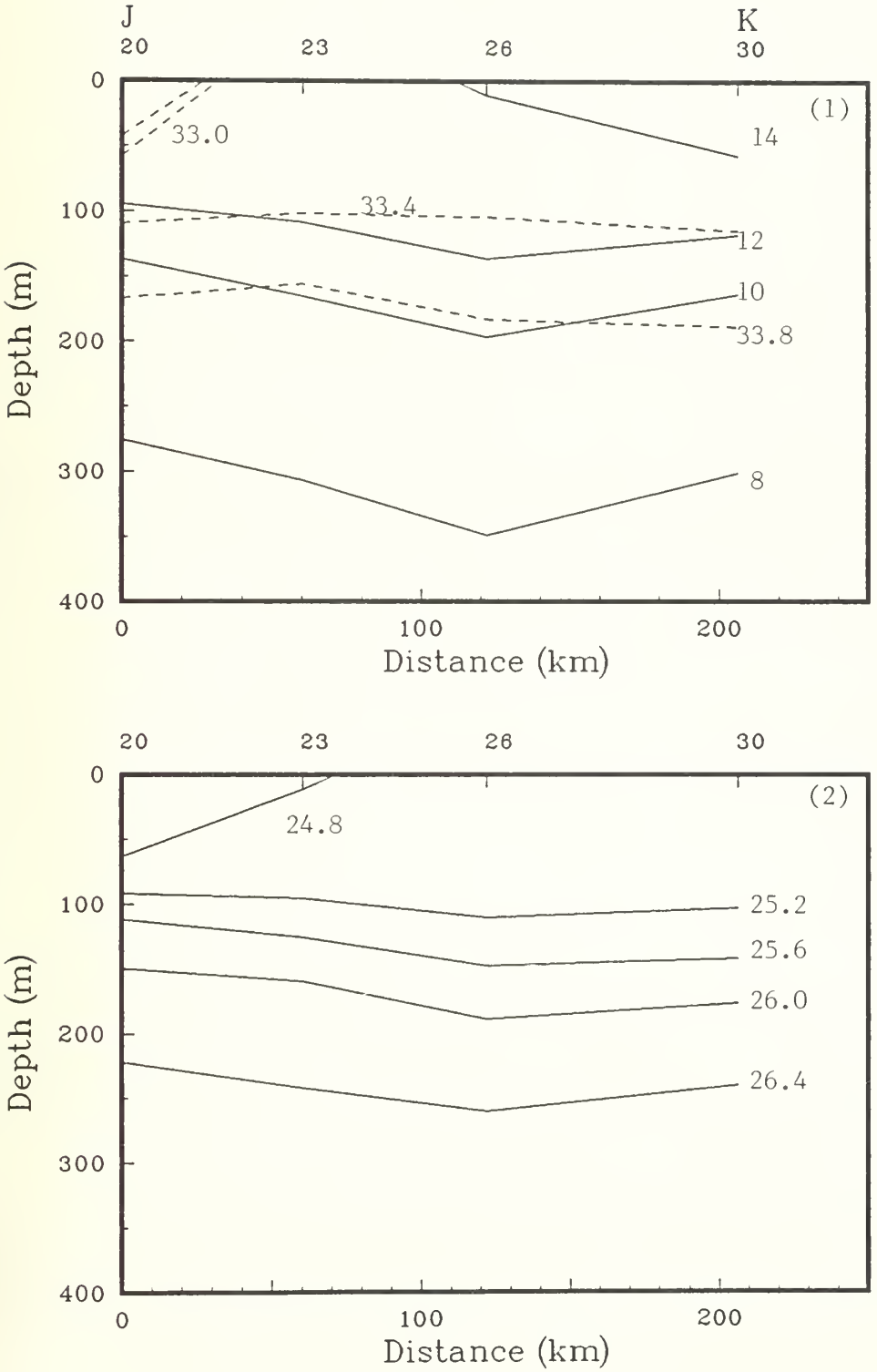

J
K
20
23
26
30
0
100
200
300
400
Depth (m)
(1)
33.0
14
33.4
12
10
33.8
8
0
100
200
Distance (km)
20
23
26
30
0
100
200
300
400
Depth (m)
(2)
24.8
25.2
25.6
26.0
26.4
0
100
200
Distance (km)

Figure 19(c)

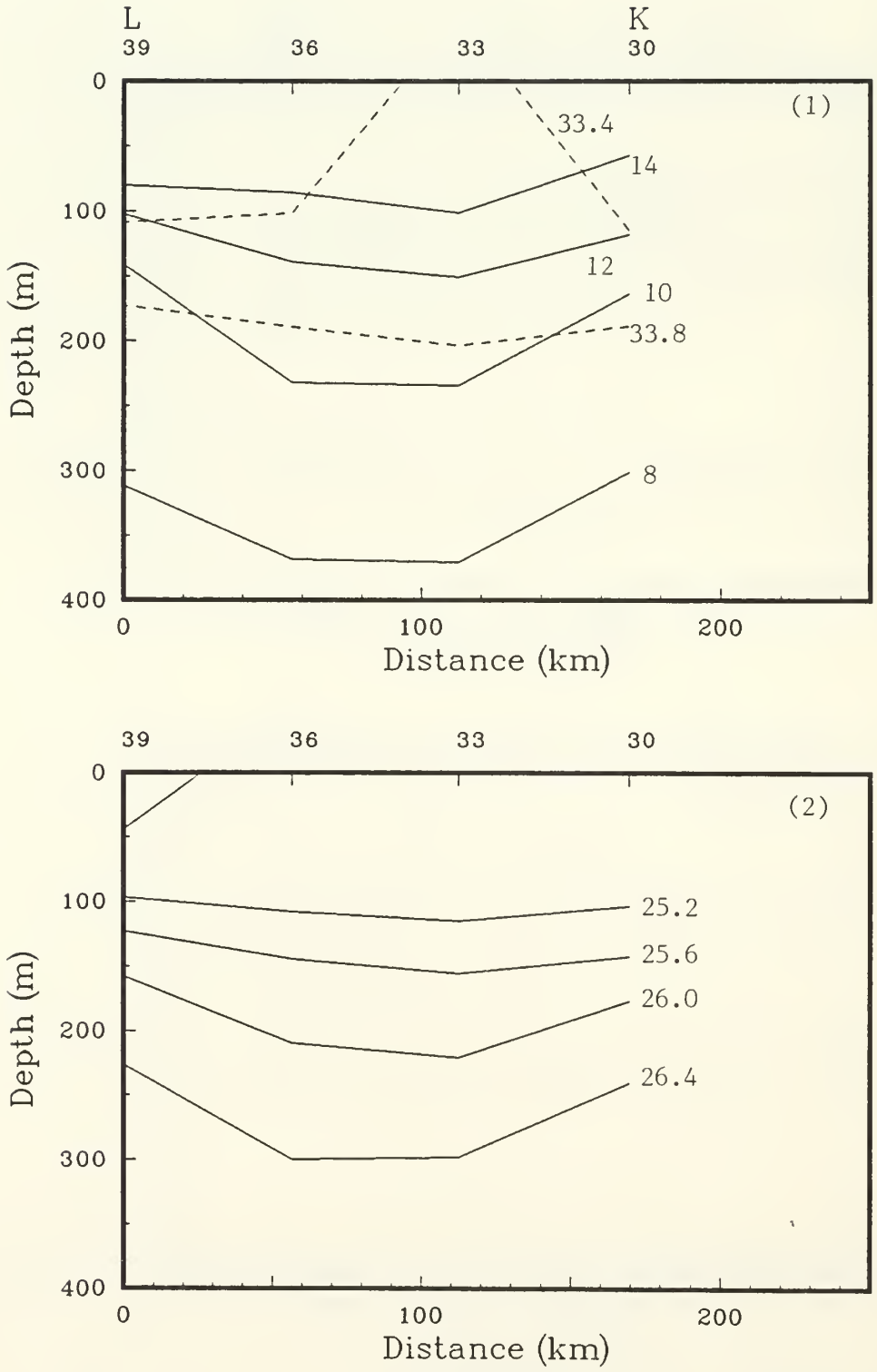

L
K
39
36
33
30
0
100
200
300
400
Depth (m)
(1)
33.4
14
12
10
33.8
8
0
100
200
Distance (km)
39
36
33
30
0
100
200
300
400
Depth (m)
(2)
25.2
25.6
26.0
26.4
0
100
200
Distance (km)

Figure 19(d)

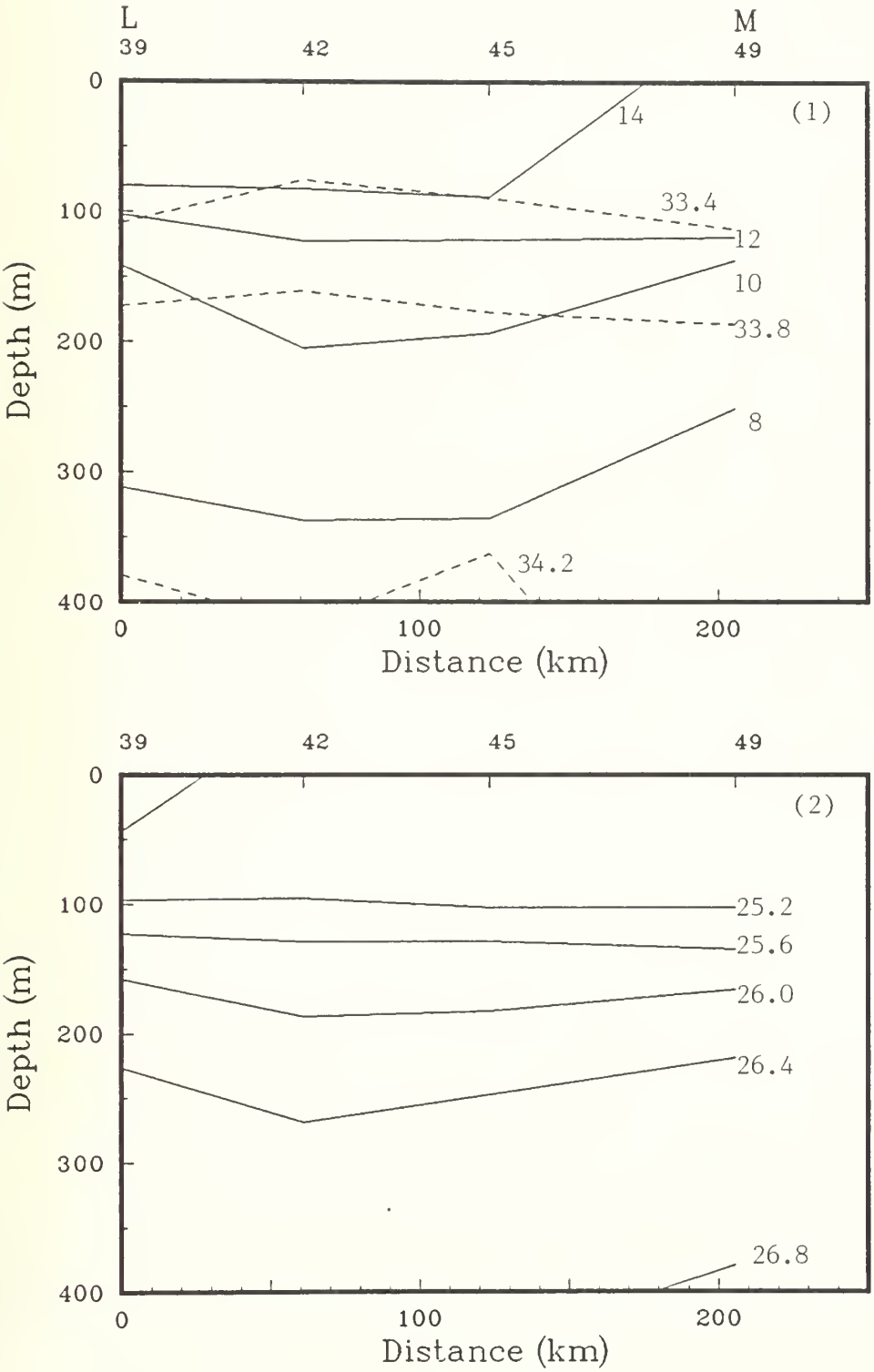

L
M
39
42
45
49
0
100
200
300
400
Depth (m)
14
(1)
33.4
12
10
33.8
8
34.2
0
100
200
Distance (km)
39
42
45
49
0
100
200
300
400
Depth (m)
(2)
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 19(e)

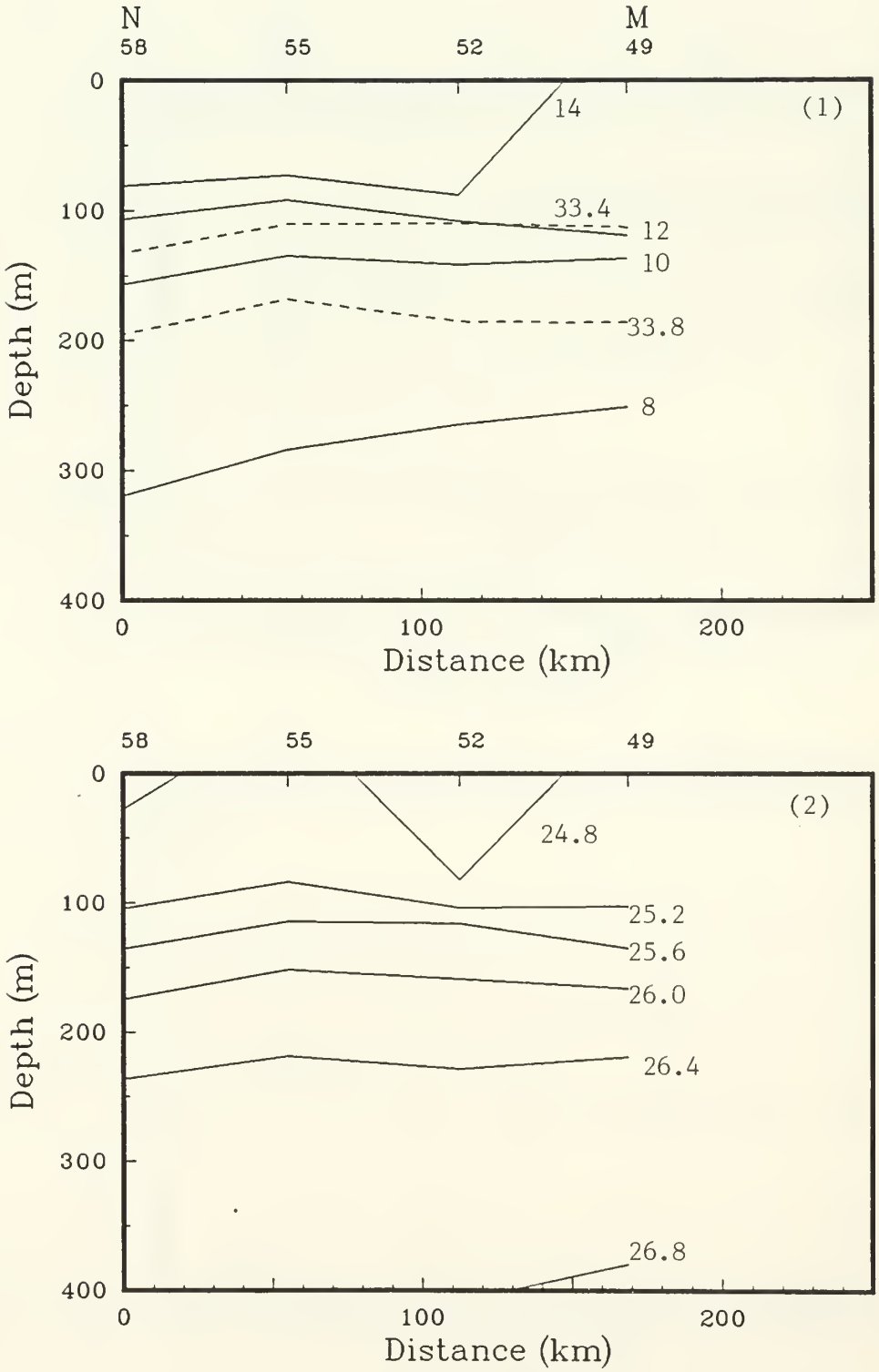

N
M
58
55
52
49
0
100
200
300
400
Depth (m)
14
(1)
33.4
12
10
33.8
8
0
100
200
Distance (km)
58
55
52
49
0
100
200
300
400
Depth (m)
(2)
24.8
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 19(f)

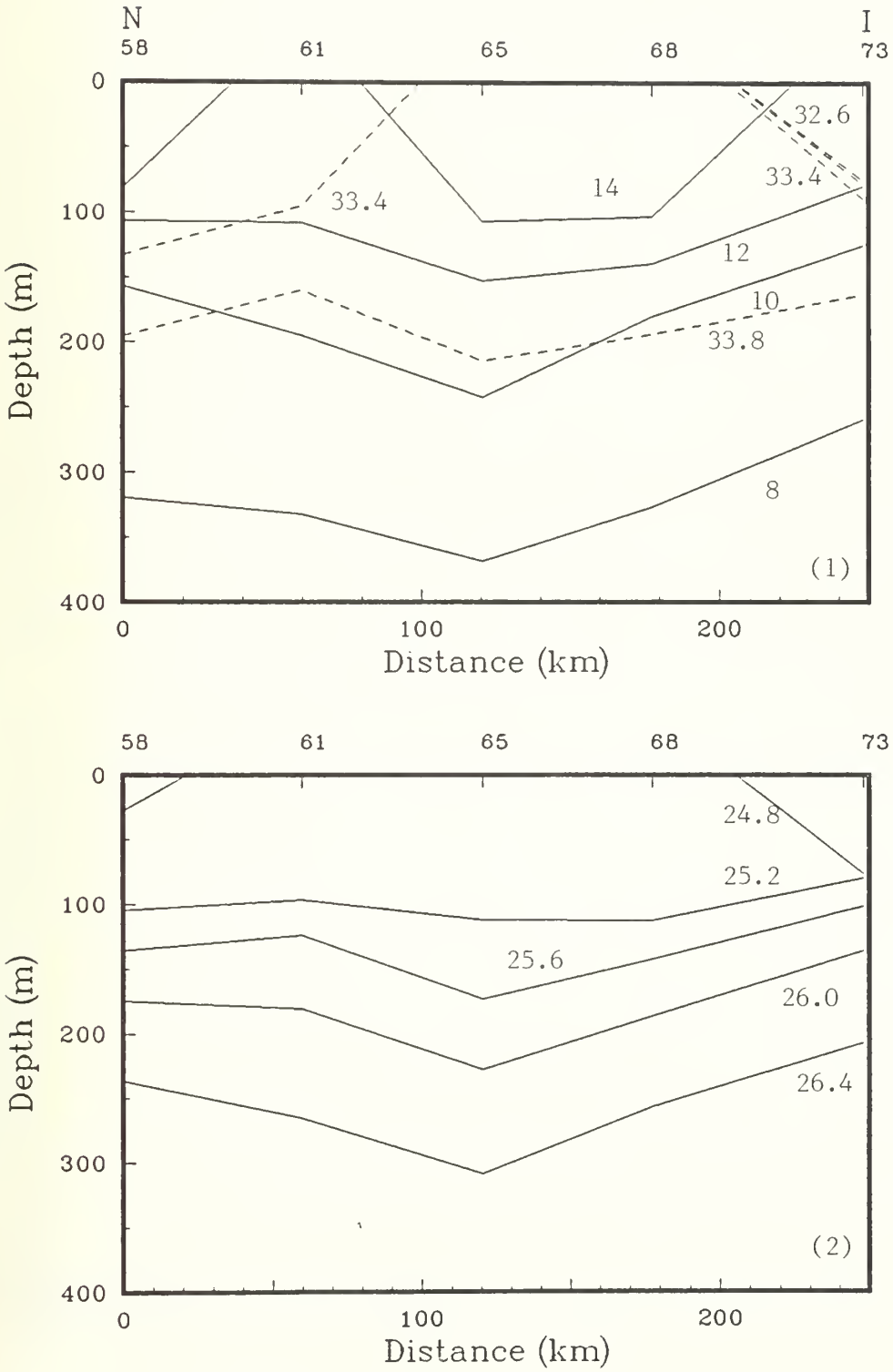

N
I
58
61
65
68
73
0
100
200
300
400
Depth (m)
32.6
33.4
14
33.4
12
10
33.8
8
(1)
0
100
200
Distance (km)
58
61
65
68
73
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
(2)
0
100
200
Distance (km)

Figure 19(g)

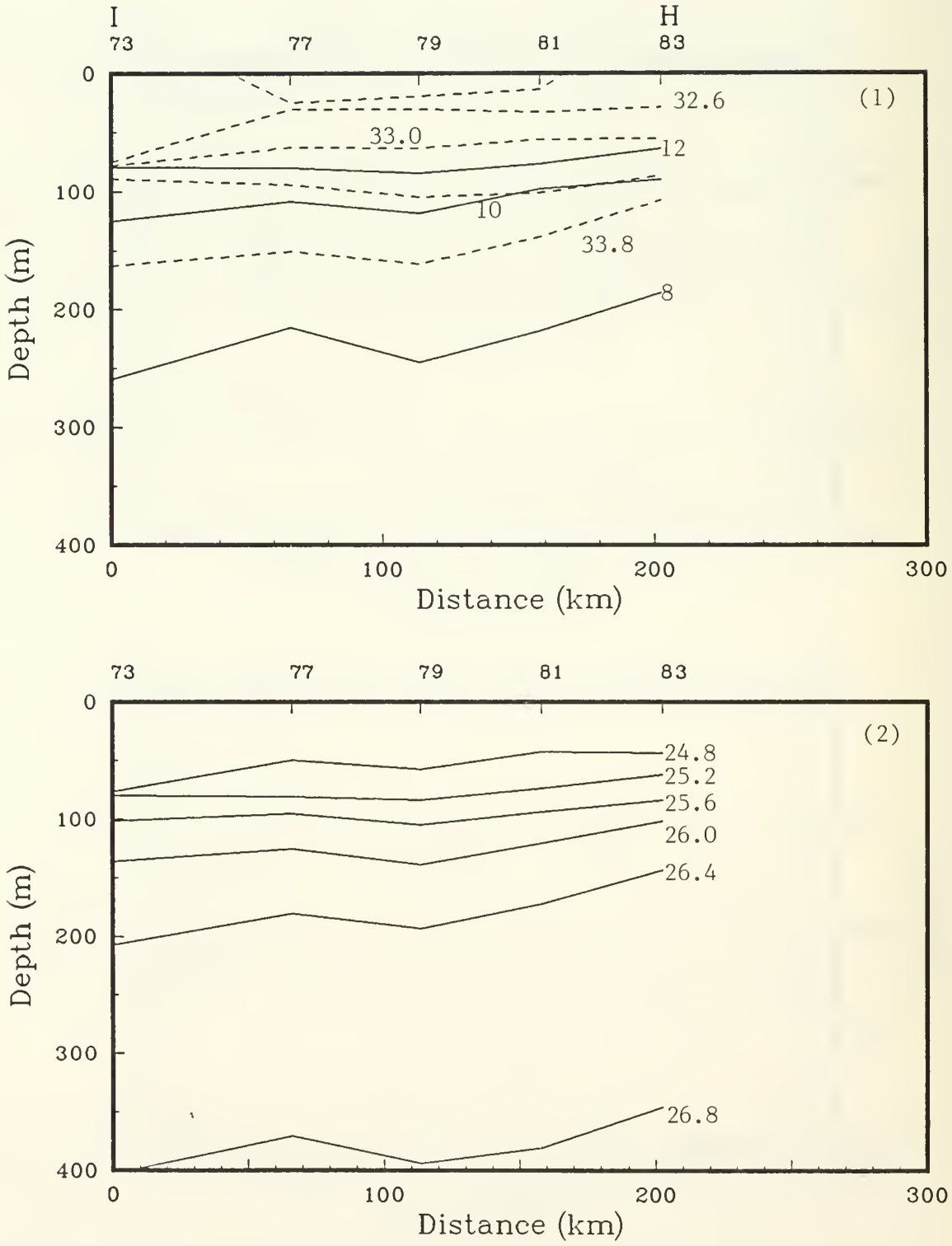

I
H
73
77
79
81
83
0
100
200
300
400
Depth (m)
(1)
32.6
33.0
12
10
33.8
8
Distance (km)
(2)
24.8
25.2
25.6
26.0
26.4
26.8

Figure 19(h)

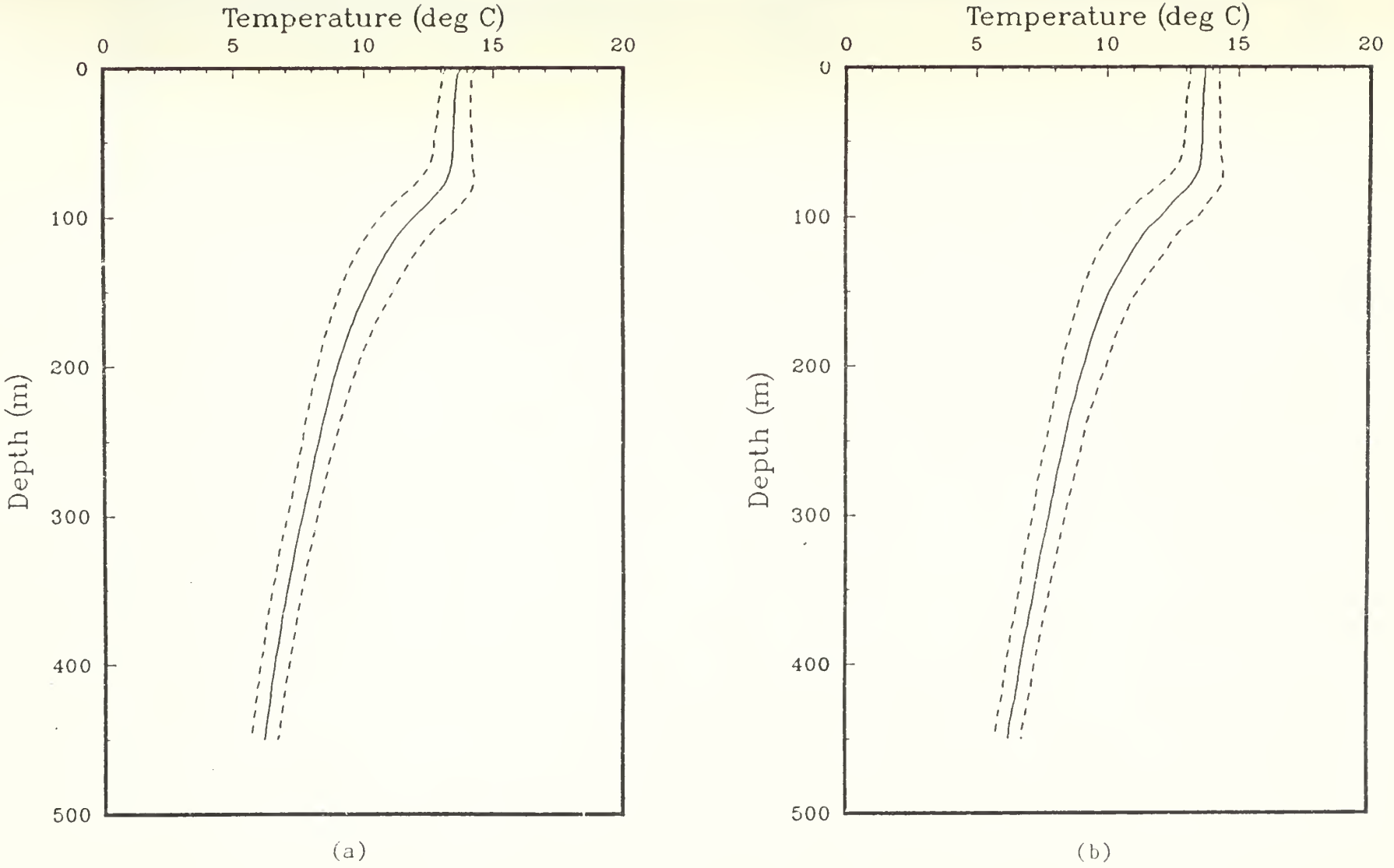


Figure 20 : Profile of $\overline{T(z)}$ with + and - the standard deviation from (a) XBT's and (b) CTD's (OPTOMA4, Leg II).

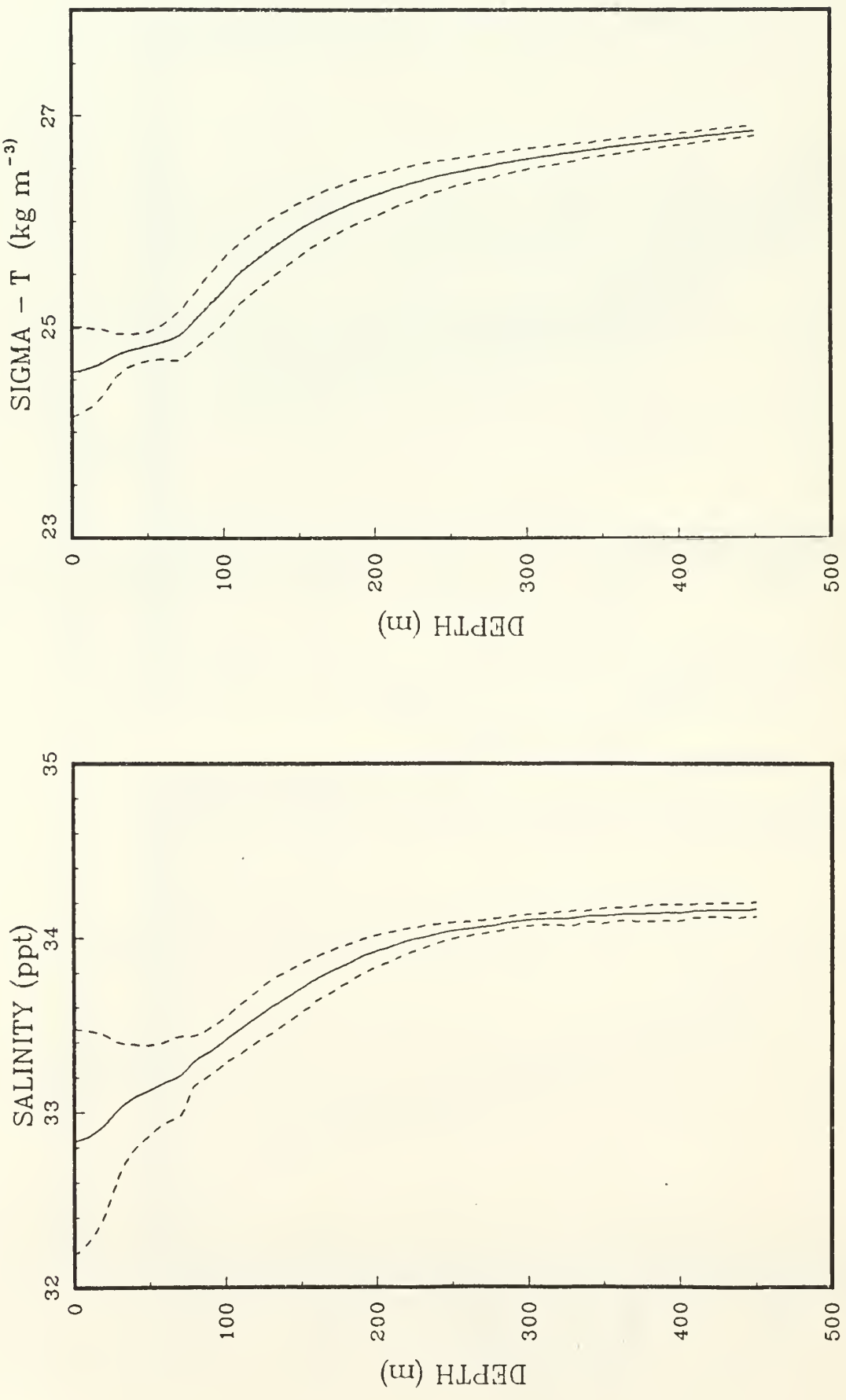


Figure 21 : Profiles of (a) mean salinity and (b) mean sigma-t, with + and - the standard deviations, from the CTD's (OPTOMA4, Leg II).

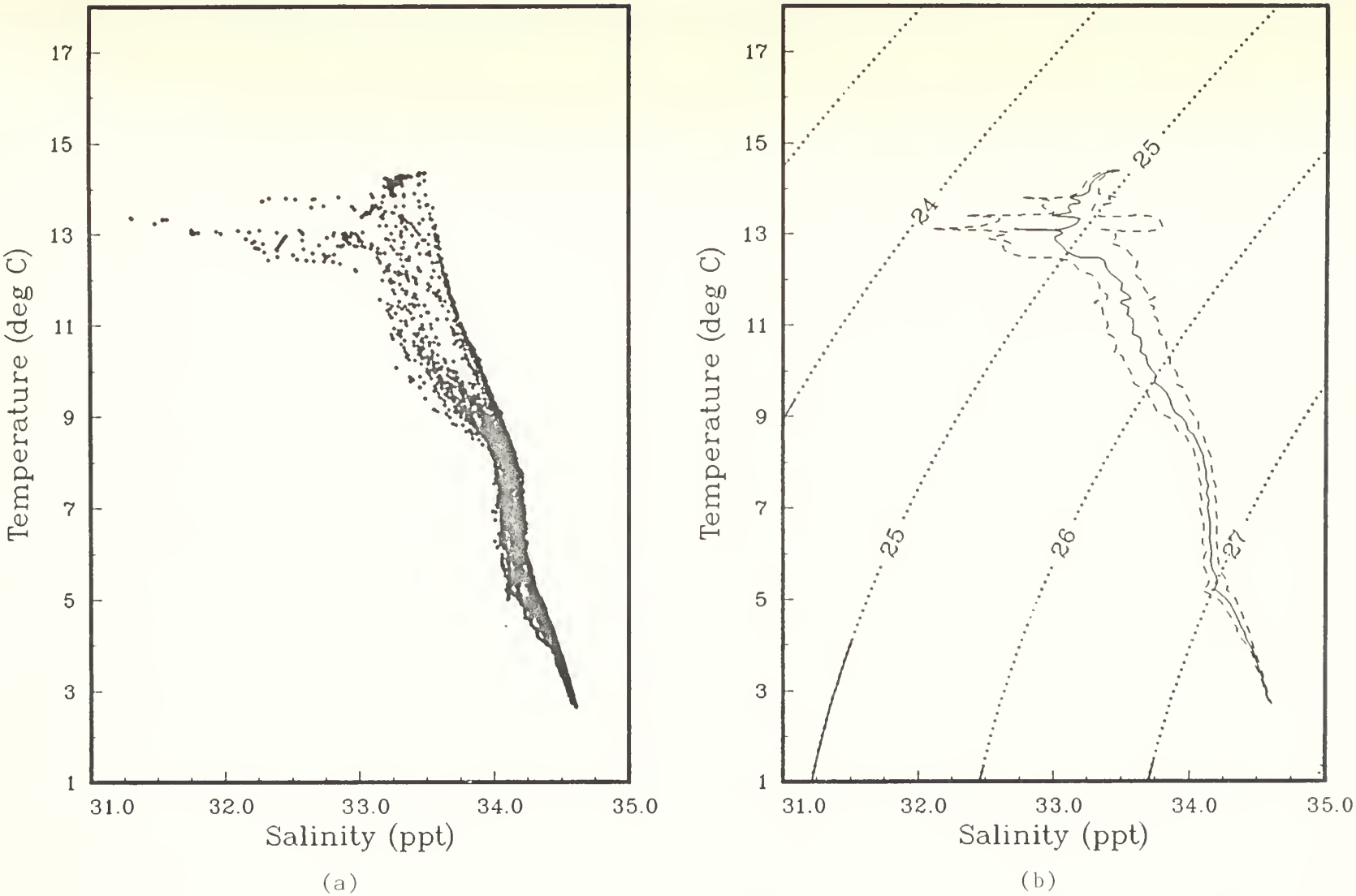


Figure 22: (a) T-S pairs and (b) mean T-S relationship, with + and - the standard deviation, and selected sigma-t contours, from the CTD casts (OPTOMA4, Leg II).

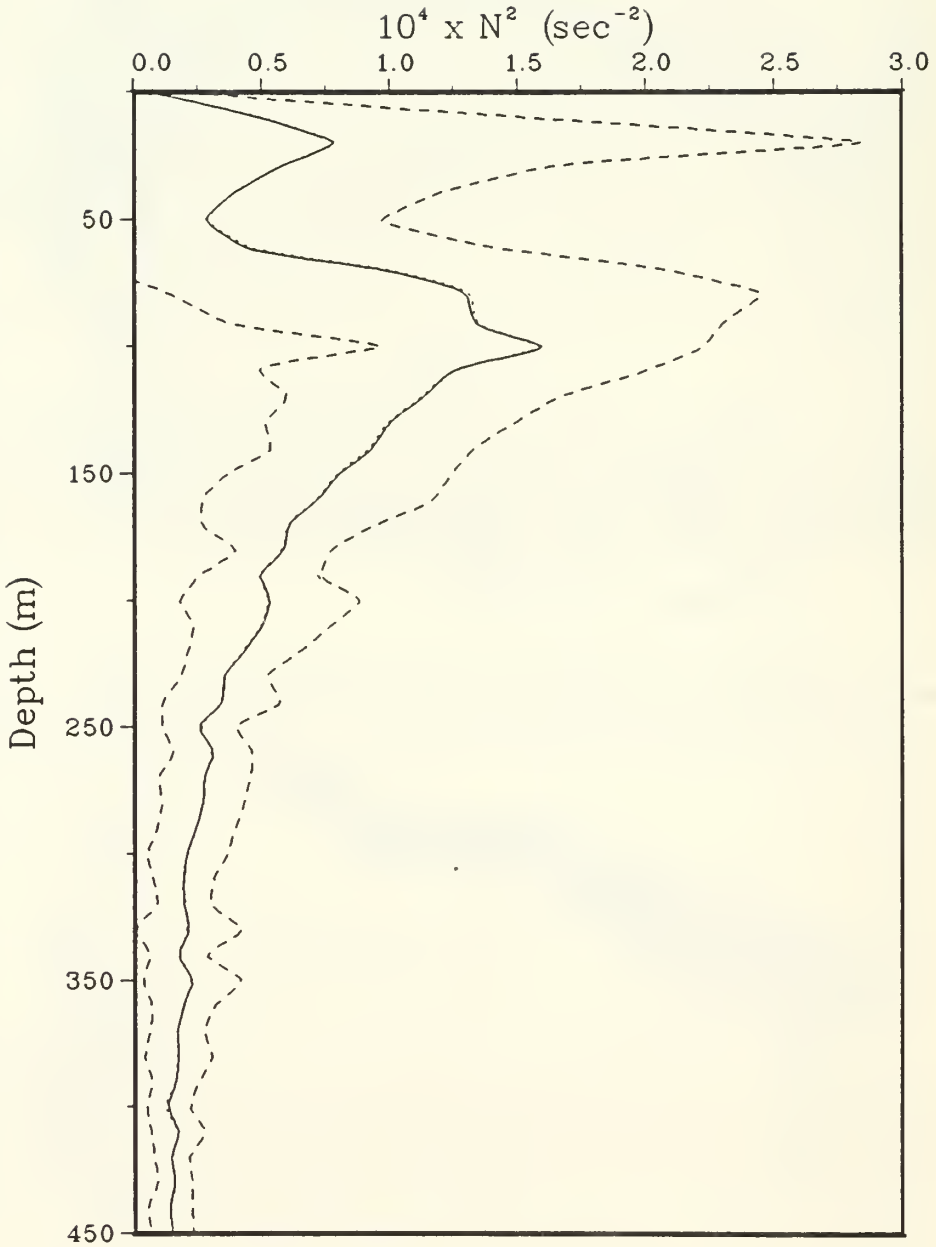


Figure 23: Profile of $\overline{N^2(z)}$ (____), with + and - the standard deviation (---), and the profile of N^2 from $\overline{T(z)}$ and $\overline{S(z)}$ (...) (OPTOMA4, Leg II).

ACKNOWLEDGEMENTS

This research was sponsored by the ONR Physical Oceanography Program. The success of the fieldwork was strongly dependent on the competent, willing support of CAPT Woodrow Reynolds, Chief Engineer Bobby Winton, and other crew members of the R/V ACANIA. Members of the scientific cruise party were:

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Mr. Geoffrey Flyer, NPS
Ms. Marie Colton, NPS
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ET3 Rief, FNOC

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Mr. Jim Stockel, NPS, Party Chief
Mr. Geoffrey Flyer, NPS
Dr. Denise Hagan, JPL
Ms. Suzanne Healy, MLML
Ms. Martha Began, MLML

REFERENCE

Lewis, E.L. and R.G. Perkin, 1981: The Practical Salinity Scale 1978: conversion of existing data. Deep Sea Res. 28A, 307-328.

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